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Miss Christine R. Hedman
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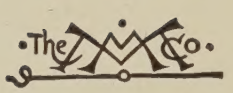
Compound —
Comminuted —

TEXTBOOK OF SURGICAL NURSING



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TEXTBOOK OF SURGICAL NURSING

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DEDICATED

IN RESPECTFUL TRIBUTE

TO THE

COURAGEOUS AND DEVOTED NURSES

WHO SACRIFICED THEIR LIVES

TO THE

CAUSE OF SUFFERING HUMANITY

IN THE GREAT WAR

PREFACE TO THE FIRST EDITION

The authors have endeavored to present as accurately and as simply as possible for the pupil nurse the actual detailed nursing of the various conditions related to things surgical. The various procedures are based on the technic employed in hospitals throughout the country, and therefore the book will be found useful as a text in training schools generally without regard to local conditions. It presupposes a thorough knowledge of the elements of practical nursing. The fundamental treatments, as a rule, have been carefully learned in the probationary periods, but a thorough understanding of the underlying principles of surgery and the necessary surgical nursing are often wanting.

While it is true that all orders are given by the surgeon, and executed with dispatch and accuracy by the nurse, the time has passed when the nurse was a mere automaton. She must know the ante- and post-operative care required for all the patients coming under her supervision. The complete management of an operating room, as well as the conversion of a private home into a suitable place for surgical procedures, should be thoroughly understood, and an operation by name, be it "glossectomy," "thyroidectomy," or "choledochotomy," etc., should immediately summon to mind the condition and the technic involved. The nurse should be well acquainted with the surgical developments of the World War, such as the Carrel-Dakin method of wound disinfection, the ambrine treatment for burns, and the suspension treatment for fractures, since her aid is essential for their proper accomplishment.

The chapter dealing with Surgical Dietetics has been based, in the main, on the diet lists used by the Presbyterian Hospital, New York. We are indebted, for the photomicrographs, to the Surgical Department of Columbia University, and for some of the pictures to the "Manual of Splints and Appliances, Medical Department, United States Army."

The authors wish to express their appreciation and thanks to Miss F. Evelyn Carling, Assistant Superintendent of Nurses, St. Luke's Hospital, New York, for her advice and many suggestions, and to Mrs. Ralph Colp and Mrs. Amy P. Phillips for their keen interest and invaluable assistance in the preparation of this volume.

PREFACE TO THE SECOND EDITION

The past few years have witnessed enormous strides in all fields of the arts and sciences, and surgery too has kept abreast with the advancements of this industrial and mechanical age.

There is no branch of surgery which has not benefited greatly and advantageously by recent research. Notable developments have taken place in gastroenterology; gastric and duodenal ulcers are being treated more radically, and the operations of subtotal gastrectomy for these conditions are becoming more common. Cholecystography has aided greatly in the diagnosis of gall bladder disease. The lung is being attacked more vigorously by the thoracic surgeon and bronchiectasis, lung tumors, and tuberculosis are passing from the realm of medical treatment to that of surgical intervention. The mortality of thyroid operations has been even further decreased, and with the use of Lugol's solution, the multiple stage operation has been practically abandoned and subtotal thyroidectomy is the operation of choice. Craniotomies for cerebral neoplasms are no longer rare and the results are more encouraging. The tannic acid treatment of burns has been an outstanding development in traumatic surgery, and the skeletal traction treatment of fractures has passed from its experimental stage. Spinal anesthesia is being used more extensively. But these are just a few of the advances in surgical treatment which may be mentioned here.

In this second edition, the entire book has been rewritten to keep pace with the recent developments in surgery and surgical nursing, and, wherever necessary, new illustrations have been added to aid the nurse in comprehending these new phases. In revising the old text, an effort has been made to note each progressive step in diagnostic and operative surgery and make it clear to the student and graduate nurse, so that efficient and excellent coöperation may be obtained based upon a sound, fundamental and scientific knowledge. For as surgery becomes bolder, it becomes more involved, more intricate, and the intelligent coöp-

eration of the surgical nurse is being taxed to the utmost, for without skilled and conscientious nursing, the progress of surgery will be materially hampered and definitely hindered.

We wish to express our thanks to those who have given their valuable constructive criticism, and to Dr. Arthur Touroff for the many excellent suggestions he has made in the preparation of this new work.

Ralph Colp
Manelva W. Keller

INTRODUCTION AND HISTORY

Surgery is as old as human needs. There have always been bleeding wounds and broken limbs, and human ingenuity has always endeavored more or less successfully to relieve the suffering so occasioned. In ancient times, the supposedly supernatural secrets of the healing art were zealously guarded from the laity, and not till the Greek Hippocrates in 460 B.C. wrote his surgical treatises did surgery pass from mysticism to science. So keen were the observations of Hippocrates that some enthusiasts claim that his two works on fractures and dislocations are in many respects unsurpassed even to-day. And until as recently as four centuries ago very little was added to the storehouse of surgical knowledge.

During the early Christian era and the Middle Ages, surgery was practised by many different classes of society, by friars and barbers, by monks and nuns, by the famous Arabian court physicians, and by ladies of noble birth. The universities from the very beginning prohibited research of any kind and demanded that every procedure be justified by the authority of Galen. Now and then solitary thinkers tried to find out things for themselves by observation and reflection. The great occupation of the majority of the people was warfare and much of the little progress in surgical knowledge owed its inspiration to the necessities of war. But even to aid the king's armies the new truths learned by experience and observation were discountenanced by the faculties of the universities. In spite of this opposition, by the fifteenth and sixteenth centuries there was a widespread awakening of the free scientific spirit. It manifested itself in the forming of groups to study and experiment in physics, chemistry, anatomy and physiology. Tremendous progress was made in all the sciences. Harvey discovered the circulation of the blood, the microscope came into use, and Fahrenheit invented the thermometer. "Western Europe broke out into a galaxy of names that outshone the utmost scientific reputations of the best

age of Greece," says H. G. Wells; and of these Vesalius and Fallopius, the anatomists, are especially honored by surgeons of to-day.

By the eighteenth century, private dissecting rooms and anatomical laboratories were flourishing. However, the surgeons themselves of this period neither helped nor shared in this great advancement of science. The barber-surgeons were an untutored lot, ready to make use of a few tricks of the trade for practical gain. The task remained to place the practice of surgery on a high plane, and this was one of the many good deeds which make the name of John Hunter shine out in the history of surgery. "More than any other man he helped to make us gentlemen," a contemporary said of him. Through the efforts of Dr. Hunter, the already existing companies of barber-surgeons were forced to study anatomy, comparative anatomy and physiology, and thus the surgical profession by the right of hard and regulated study began to take rank with the high order of scientists. Public museums of anatomy and physiology were founded; the method of clinical teaching was adopted; and in the beginning of the nineteenth century the day of painless operation had come with the discovery of anesthesia.

Still the surgeon was held in disrepute. The dark ages when investigation was forbidden were passed; all the sciences aided the surgeon; he progressed with the great advance in anatomy, physiology and pathology. And yet, the hospitals where he operated were considered houses of certain death. An operation was in truth a sad affair. No matter how great the technical skill of the surgeon, patients, more often than not, died of blood poisoning. Now and then a wound did heal without the formation of pus, but both spontaneous and operative wounds almost invariably became infected, with death as the result. So common was this, particularly in hospitals, that many surgeons feared to operate at all. The term "hospitalism" was coined by Sir James Y. Simpson, who collected statistics proving that private patients were far less liable to succumb from operation than those treated in hospitals.

With the advent of Lister came "a light that brightens more and more as the years give us ever fuller knowledge," as Sir William Osler has said. It was to the researches of Pasteur, the great French scientist, that Lister owed his inspiration. One

of the first practical results of Pasteur's studies on fermentation and spontaneous generation was a great transformation in the practice and results of surgery. It is not too much to claim this as one of the greatest boons ever conferred on humanity. Let us quote from Lister's paper on the subject which appeared in the London *Lancet*, 1867.

"Turning now to the question of how the atmosphere produces decomposition of organic substances, we find that a flood of light has been thrown upon this most important subject by the researches of Pasteur, who has demonstrated by thoroughly convincing evidence that it is not to its oxygen or to any of its gaseous constituents that the air owes this property, but to minute particles suspended in it which are the germs of various low forms of life long since revealed by the microscope and regarded as merely accidental concomitants of putrescence, but now shown by Pasteur to be its essential cause, resolving the complex organic compounds into substances of simpler chemical constitution, just as the yeast plant converts sugar into alcohol and carbonic acid."

From Lister's work modern surgery takes its rise and the whole subject of wound infection, not only in relation to surgical diseases but also to childbed or puerperal fever, now forms one of the most brilliant chapters in the history of Preventive Medicine. So great have been the results of Lister's work that it is indeed almost difficult from our fortunate position of to-day to glimpse the sad position of the surgeons of his time. In present-day hospitals surgical infection and puerperal fevers are almost things of the past, and for these achievements alone the names of Louis Pasteur and Joseph Lister will go down to posterity as among the greatest benefactors of humanity.

Lister's work was the beginning of antiseptic surgery. Surgeons at last learned to combat with a strong antiseptic the germs which existed in the air, the wound, the room, the surgeon's hands, his instruments. The black-robed, professorial-looking surgeon of earlier times was succeeded by a surgeon clothed in immaculate white. For an operation in the true Listerian style, the part to be operated on was first of all enveloped two hours before the operation in a towel soaked in carbolic acid, to destroy the germs present in the skin. Instruments and sponges lay for a half hour in a flat porcelain dish of carbolic acid. Towels

soaked in this solution covered the tables and blankets near the part to be operated on. The hands of the surgeons and nurses were thoroughly washed in the same solution. The operation itself was performed under a cloud of carbolized vapor from a steam spray producer. Then a strip of oiled silk, coated with carbolized dextrin and further washed in carbolic lotion, was placed over the wound and over this was applied a double ply of carbolic-soaked gauze, covered with eight layers of dry gauze. Finally came a thin mackintosh cloth, and this whole apparatus was covered with a gauze bandage. The mackintosh cloth served to prevent the carbolic acid from escaping and at the same time permitted the discharge from the wound to spread through the gauze. The vapor given off by the carbolic gauze shielded the wound and the surrounding parts from septic contamination. These conditions were very strictly maintained until the wound was healed.

All these cumbersome and complicated measures may seem a bit unnecessary to us; especially may we sigh when we reflect that the use of carbolic acid made Lister's hands red and raw. Some surgeons produced excellent results by methods of strict cleanliness without following the whole Listerian technic. Gradually, Lister himself gave up most of these measures, much to the advantage of the patient, for that same carbolic acid which so effectively destroyed pathogenic bacteria in and about a wound, invariably injured the exposed tissues also. The great achievement of Lister was not the spray and gauze method, but the conclusive proof that cleanliness is the most essential factor in successful operating.

To the antiseptic surgeon of 1867 has succeeded the aseptic surgeon of to-day. The aseptic surgeon uses steam and hot water to sterilize all materials employed in the operative procedure, and not only does he carefully scrub his hands, but he also renders them absolutely germ-proof by wearing rubber gloves which have been previously sterilized by boiling water and steam. Such is the simple aseptic method which has been gradually evolved from the Listerian antiseptic system. The spray producer has almost passed into oblivion, but the spirit of Lister's teachings—scientific cleanliness—still guides the surgeon's work.

In the World War aseptic surgery proved of little avail, because almost all wounds were contaminated and filled with pus.

The wound of the battlefield is not similar to the operative wound of the civilian hospital. Even with the utmost efficiency, before those wounded in modern warfare can be conveyed to the nearest surgical station much time will have elapsed with ample opportunity for contamination. To deal with these conditions, the antiseptic method was revived. This time, however, the strong carbolic acid of Listerian fame was replaced by an agent harmless to the tissues, the Carrel-Dakin solution. This solution is not merely one of historical interest, but widely used by surgeons of to-day for a certain type of wound, and it will be discussed in detail in Chapter XX.

To-day the vision of surgery is glorious. The surgeon is everywhere recognized as an indispensable worker in the community. The growth of a highly competent, scientifically trained nursing staff has more than doubled the good results of his work. Nurses have indeed existed from earliest Christian times; they have either been gentle, noble-minded Sisters of Mercy in the convents, or uneducated, inefficient maids in hospitals. Neither of these classes was what could be called trained or educated according to the present view of what training and education should be for a nurse. The first training-school for nurses was established as recently as 1836. This little school at Kaiserswerth, Germany, is the mother of the present system; within its walls Florence Nightingale acquired her practical knowledge of nursing in a few months' time. Miss Nightingale was a woman of genius and vision. During the Crimean War the London *Times* roused British public opinion by its vivid account of the terrible conditions in the military hospitals of the war zone, and Miss Nightingale set out for that region with a staff of trained nurses to superintend the care of the sick and wounded. What she actually accomplished was of greater importance to humanity than nursing individual soldiers stricken in the Crimea. She applied the principles of hygiene to hospital administration and brought light, cleanliness and order out of indescribable chaos and misery. The "lady with the lamp" at Scutari showed what a hospital should be and what scientific nursing should mean. Although her work in the Crimea was done more than a score of years before Lister's revolution in surgery, Miss Nightingale's revolution in hospital building, administration and management was based on the Listerian idea of scientific cleanliness. And

out of her work in the Crimea arose trained nursing on a large scale. In 1860 the modern hospital school system was inaugurated by her in Great Britain at St. Thomas's Hospital, London. The dignity of the nursing profession has thus been raised; it has become a calling for superior women, with the recognition of the need for a rigid education and training before the nurse can call herself a "graduate." Just as surgeons were made "gentlemen" by the work of John Hunter, so nurses through the efforts of Florence Nightingale were made "ladies," and their profession put on a very high plane of social usefulness.

In the same decade that the Nightingale Fund School was founded at St. Thomas's, Lister's great work was given to the world. That is, the rise of modern surgery is contemporaneous with the beginning of a careful, trained nursing body. This is more than an historical coincidence, for since that time the increasing demands of medical and surgical knowledge have well nigh revolutionized the nursing craft. To-day the surgeon in the operating room of the hospital or in the private home has come to rely absolutely on a highly educated and trained nurse. To her he leaves the preparation of supplies, the preparation of the operating room and instruments, and the preparation of the patient; she even assists the surgeon in the operation itself in many ways. And finally, most of the after care of the patient is left entirely to the nurse. It is a great need that the nurse fills, a need that will grow with her capacity to fill a greater sphere. She is the Handmaid of Surgery and must live up to that high social calling by being well prepared; she must be so educated and trained that she will not be a mere automatic tool, but an intelligent, enthusiastic coworker, filled with a zeal for science, and giving her whole mind and heart to the work that is before her—for only recently in the history of surgery is there scientific surgical nursing. The surgical nurse is a pioneer; the trail has been blazed; but it is still a new one, and she must show what she can do.

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TEXTBOOK OF SURGICAL NURSING

CHAPTER I

PATHOLOGY

The surgical field may be divided into those conditions which are due to inflammation, injuries, congenital deformities, and new growths. Into these arbitrary four great divisions all modern surgical intervention falls. And since all surgical intervention is to a greater or lesser degree supplemented by surgical nursing, a thorough and intelligent understanding of the underlying pathological process is essential. Perhaps the most common field is that of inflammation.

INFLAMMATION

Inflammation may be said to be the reaction of irritated damaged tissues which still retain vitality. It is a protective device on the part of nature. It has for its ultimate end the replacement of destroyed tissue. It is for the benefit of the individual, and the entire pathological and clinical process must be looked upon in this light.

The things which cause injury to tissues may be divided into several groups. They may be *physical* or *mechanical*, *chemical*, *electrical*, *thermal*, and *bacteriological*. A cut from a knife, a bruise from a stone, or a contusion from a flying timber may be considered physical or mechanical agents damaging tissue. An electrical insult might result from touching a "live" wire, while a burn from fire, or a frost bite from the cold, might be classified under thermal destruction of tissue. Conditions like acute appendicitis or a boil are invariably bacteriological in origin. The last mentioned is most important, for it results in the majority of diseases demanding surgical intervention and is the direct cause of operative and non-operative wound infection. These five agents then are the exciting factors of an inflammatory reaction; they have in some way injured or destroyed the unit structure of the body, the cell, and in order to carry off the

dead and dying cells, to replace them, and rebuild the damage done, the process of inflammation must ensue.

What is the process of inflammation? The following, in a brief way, will illustrate what happens grossly, and what occurs if the process were to be studied underneath the microscope:

If a finger is cut, it bleeds. The amount of blood lost is dependent upon the size of the vessel cut. In time, due to clotting, the bleeding ceases and within a few hours the surrounding skin may become red, perhaps slightly swollen. Pain is invariably present because of the increased pressure on the nerves due to the inflammatory exudation, and because of the pain there is usually interference with function. If the temperature of the part should be taken, it would be higher than that of the adjacent skin. The wound is now said to be inflamed, and the cardinal signs of clinical inflammation, redness, swelling, heat, pain, and loss of function, are present.

If this process were examined in sections beneath a microscope, a very interesting and thoroughly instructive picture would be seen, depending upon the time when the section was taken. Within a short period after the original injury, there would be along the line of the original incision a clot of blood, and adjacent to it some dead cells. (Fig. 1.) Already, the products of these dead cells would have stimulated a greater blood flow to the part, resulting in a dilatation of blood vessels and capillaries, and an infiltration of the tissues with white blood cells, red blood cells, and serum. Naturally it is this that makes the part swollen, red, warm, and painful.

It has already been noted that cells have been destroyed. Dead tissue is of no use to the organism. It must be removed, and the white blood cells carry off the destroyed tissue. It is a known fact that when cells are injured, those which are but slightly traumatized are actually stimulated to growth, and these cells (fibroblasts) immediately begin to reproduce and grow into the blood clot along the fibrin strands (Fig. 2) in an attempt to bridge in the gap caused by the destruction of the cells killed by the knife. In small wounds this is barely visible to the naked eye, but in wounds in which a definite area of tissue has been destroyed, or wounds with definite loss of substance, this new growth of cells together with a new growth of blood vessels is known as *granulation tissue*. (Fig. 3.)

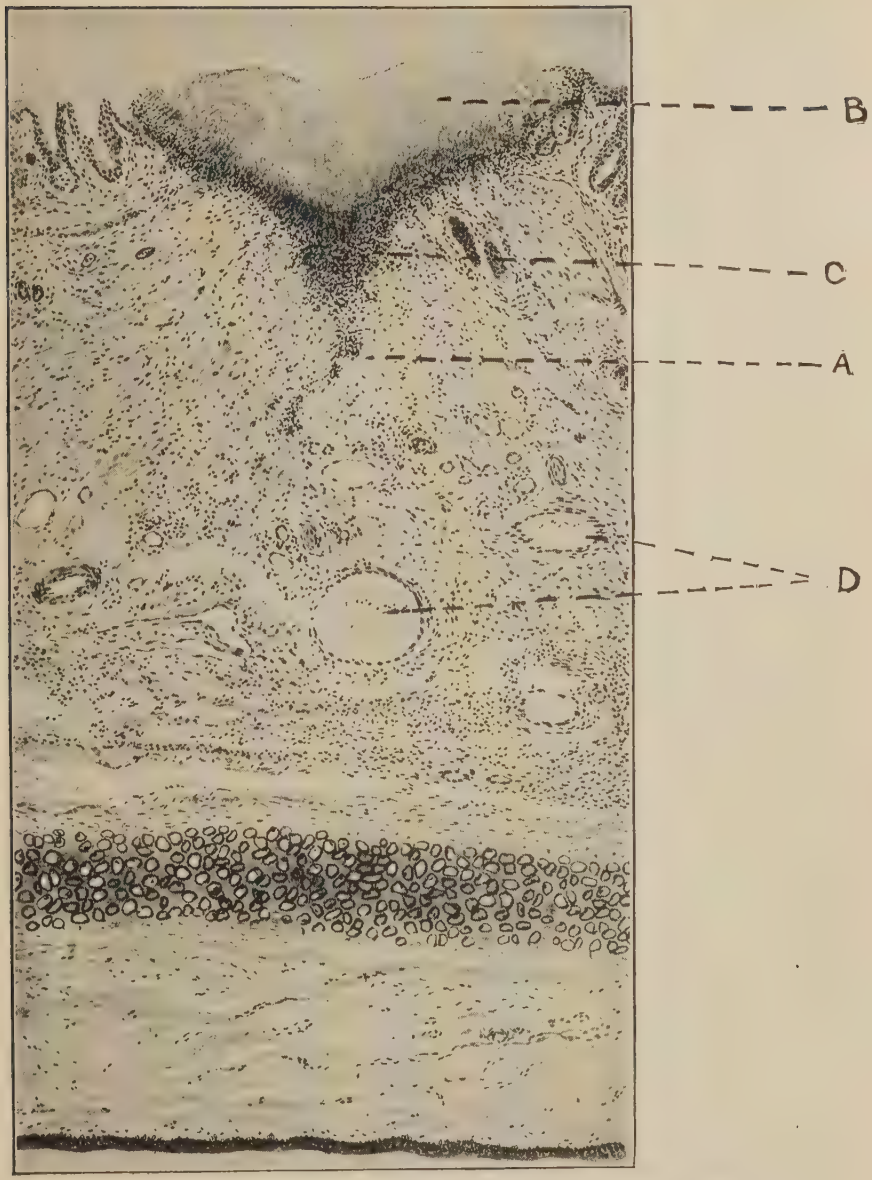


FIG. 1.—MICROSCOPIC DRAWING OF INCISED WOUND 24 HOURS OLD. *A*, line of incision; *B*, blood clot; *C*, cellular infiltration; *D*, relative dilatation of blood vessels. Published by permission of the Department of Surgery, Columbia University.

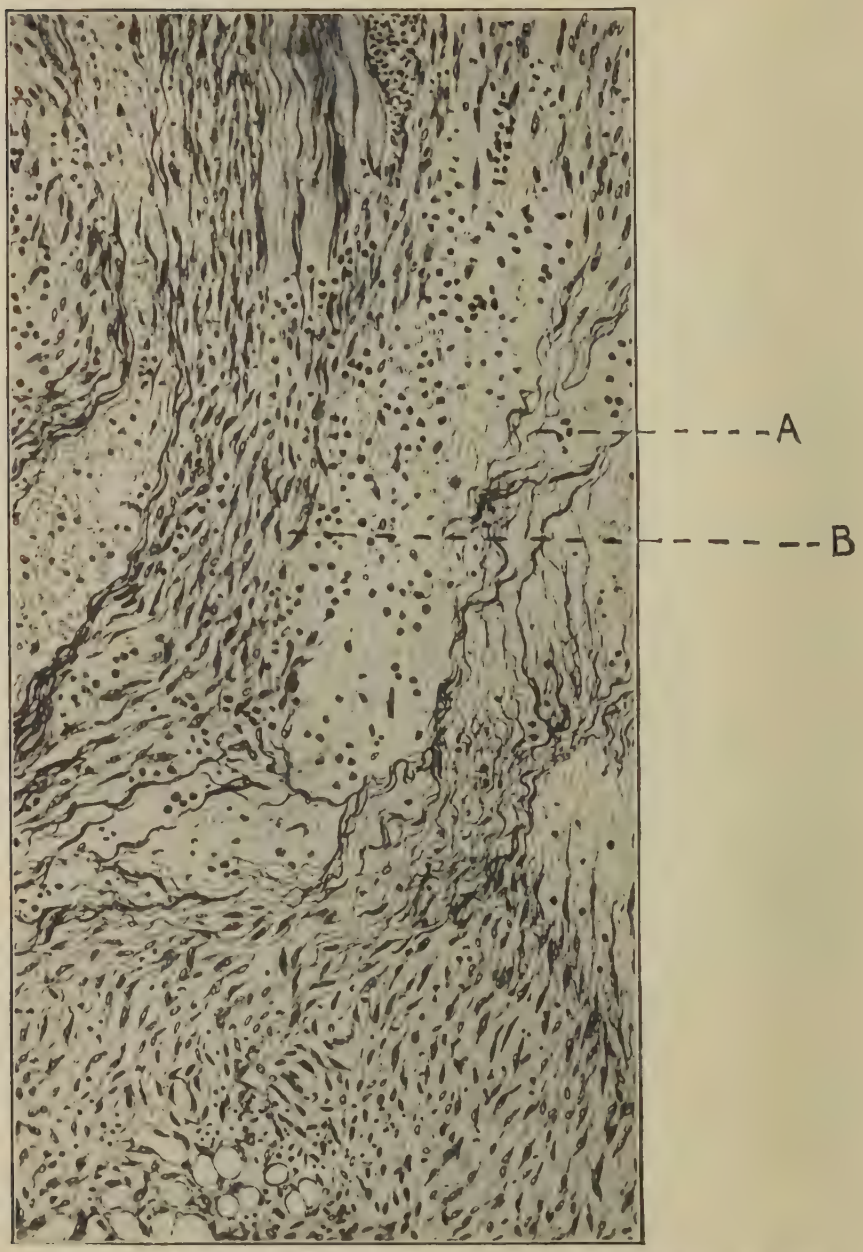


FIG. 2.—MICROSCOPIC DRAWING ILLUSTRATING THE GROWTH OF FIBROBLASTS ALONG FIBRIN STRANDS OF THE BLOOD CLOT. *A*, fibrin strands; *B*, fibroblasts. Published by permission of the Department of Seurgery, Columbia University.

This newly formed tissue is bright red in color, is highly vascular, and bleeds easily, but may be cut away or cauterized without pain because the nerve fibers as yet are absent. Wounds

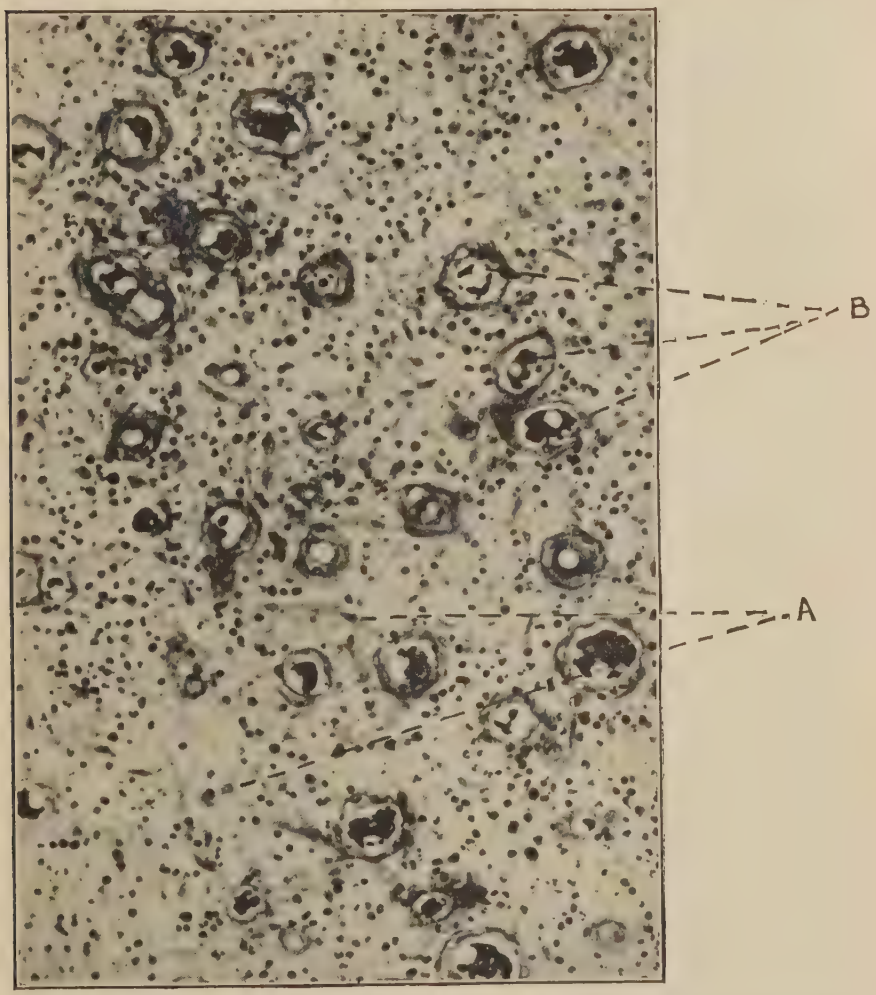


FIG. 3.—MICROSCOPIC DRAWING OF GRANULATION TISSUE. *A*, fibroblasts; *B*, newly formed blood vessels. Published by permission of the Department of Surgery, Columbia University.

which have been sutured or small cuts on a finger which heal with the minimal amount of granulation tissue are said to heal by *primary intention*. Wounds in which there is a loss of tissue from one or another cause, in which the repair is effected by

FIG. 4.—MICROSCOPIC DRAWING OF AN INFECTED WOUND. *A*, infected wound; *B*, surface granulation tissue.

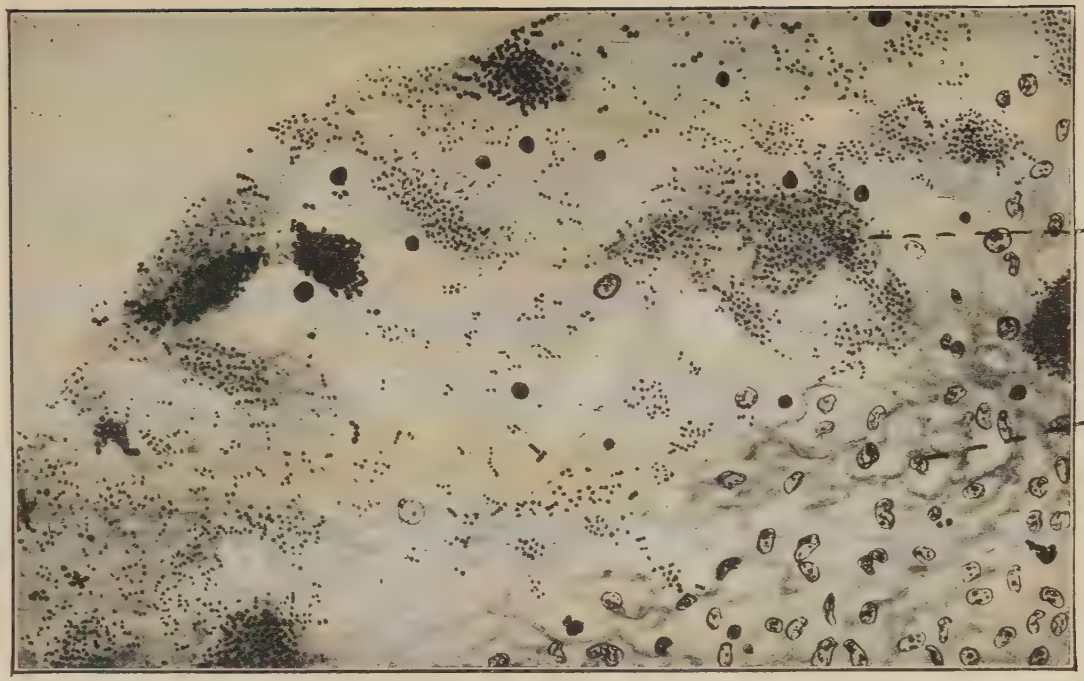


FIG. 5.—MICROSCOPIC DETAIL DRAWING OF *B* OF FIG. 4; *C*, bacteria in the wound and pus; *D*, granulation tissue. Published by permission of the Department of Surgery, Columbia University.

filling in the space with granulation tissue, are said to heal by *secondary intention.* This process of healing takes place in every wound. It is fundamentally the same in all types of tissue, epithelium, nerve, muscle and connective tissue, and in all clean wounds, whether a cut of the finger, the healing following a cyst enucleation, or an incision through the abdominal wall. The process is slightly different, however, when the wound becomes contaminated by bacteria of the pathological variety.

In a clean wound the minimum amount of damage is done because the only cells destroyed are those which have been killed by the knife of the surgeon. But if this knife were not properly sterilized and were laden with bacteria, the result would be an *infected wound* (Fig. 4), and the outcome would be dependent upon the resistance of the individual infected and the severity of the infecting organisms. These bacteria destroy cells in the same way as a knife. And, because of their irritating properties and their attempts to invade and destroy the body, Nature summons the white blood cells (phagocytes, called by Metchnikoff the "policemen of the blood") to arrest the onslaughts of the invading foes. These white blood cells attempt to destroy bacteria. If they are successful, the bacteria remain local in position, an abscess is formed (Fig. 6) and the evidences of the combat are found by the appearance of pus in the wound. *Pus* is composed of living and dead bacteria, living and dead white blood cells. Naturally, in such a process, more tissue will be destroyed than in a clean wound.

A wound in which there is pus is spoken of as a *suppurating wound,* and the process is known as suppuration. When tissue has been destroyed by the bacteria and the individual has been fortunate enough to cause the process to remain localized, the dead tissue will fall off from the living; the line formed between the living and dead tissue is called a *line of demarcation.* This dead tissue is spoken of as slough and very often it may be seen lying in a wound as strands of yellow greenish débris. In those instances in which the amount of tissue destroyed, for one reason or another, is as large as a toe or an entire extremity the process is known as *gangrene* or mortification.

If the individual through some constitutional inferiority has been unable to localize the bacteria, their poisons may be absorbed into the blood vessels directly. The patient then be-

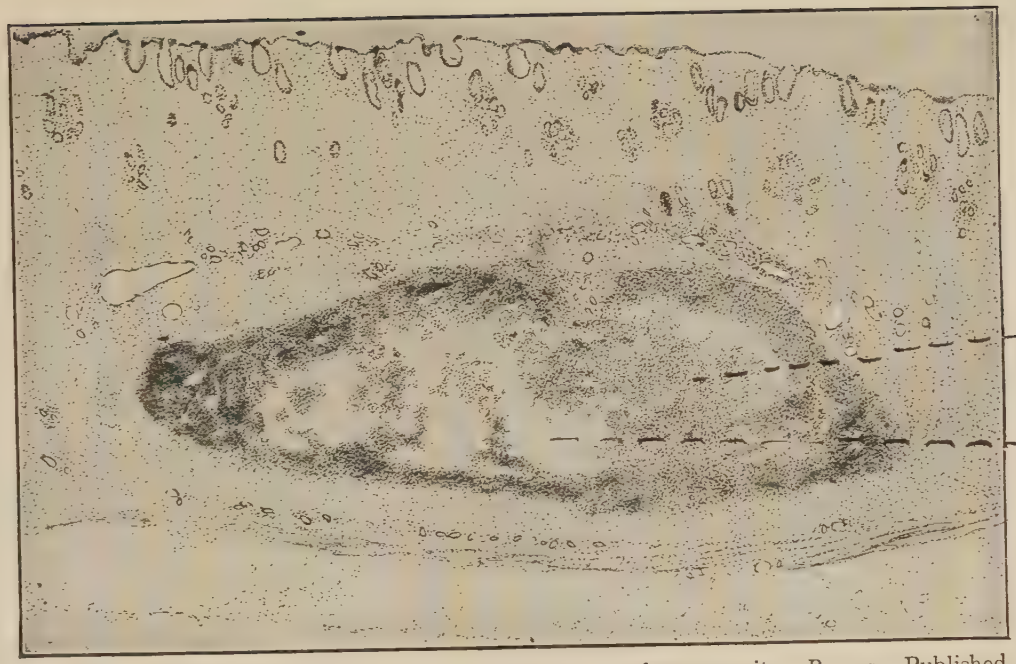


FIG. 6.—MICROSCOPIC DRAWING OF A DEEP ABSCESS. *A*, abscess cavity; *B*, pus. Published by permission of the Department of Surgery, Columbia University.

comes toxic, and the condition is known as *toxemia*. If not only the toxins of the bacteria, but the actual bacteria themselves are absorbed, a sepsis, *septicemia*, or *bacteremia* results. The laity call this "blood poisoning."

If the pus itself, or collections of bacteria, should localize in different parts of the body and form smaller or secondary abscesses, either in the skin or other organs, the condition is known as *pyemia*. Sepsis and pyemia are indeed serious complications, for they often spell death to the patient. If they follow in the path of clean operations they are due to carelessness on the part of the surgeon or the nurse. They are a blot on the scalpel of aseptic surgery. They mean that certain bacteria entered the wound either before, during, or after operation. The bacteria which cause wound infections are numerous and varied. A classification of these organisms is herewith given:

Bacteria are of two classes:—*saprophytes*, those which live on dead organic matter, and *parasites*, which derive their nourishment from living bodies. The latter class produce the pathogenic or disease bacteria: these are either cocci or bacilli. The various common cocci may be divided into staphylococcus, streptococcus, pneumococcus, meningococcus, gonococcus, micrococcus catarrhalis and diplococcus intracellularis; the bacilli, into the bacillus coli communis, bacillus typhosus, bacillus paratyphosus, diphtheria bacillus, influenza bacillus and bacillus pyocyaneus. These are the germs which are concerned in acute inflammations. There are others which cause chronic inflammations, the most important of which are the tubercle bacillus and the spirochaete of syphilis. Then there are those rarer forms of inflammation which are due to the bacilli of anthrax, of glanders, and those due to the fungi group, such as actinomycosis.

All these bacteria are *aerobic*, the type which need oxygen for their existence, but there is a distinct group, the *anaerobic* organisms, which thrive best where there is no or very little oxygen. The tetanus bacillus and the Welch bacillus are in this group, and the surgical complications which these cause will be discussed in Chapter IV.

The pathological process involving these is essentially the same; it is simply a question of degree and intensity; it is dependent upon the virulence of the organism causing the infection, and the general resistive powers of the patient infected.

How do bacteria enter the body? They may enter through the *broken skin and mucous membranes*, giving rise to local inflammation with destruction of tissue, and abscess formation. In addition they may gain access to the lymphatics draining the infected area, causing *lymphangitis*, and often the lymph nodes becoming tender, hard, and swollen (*lymphadenitis*). Or the bacteria may enter the blood stream directly, resulting in septicemia or pyemia.

Inhalation is the means by which the pathogenic bacteria enter the various nasal sinuses and the trachea and lungs, causing the majority of respiratory diseases. By *ingestion* of food and drink, the germs may enter the tonsils or the alimentary canal. Another portal of entry in females is through the *Fallopian tubes* directly into the peritoneal cavity, causing peritonitis with its various complications.

If the body is in good health and properly nourished, all these portals are safely guarded, but if the individual is weakened and the various protective mechanisms are at fault, disease readily ensues.

INJURIES

Injuries may be caused by the various factors already mentioned. These really constitute the field of traumatic surgery, the surgery of fractures, dislocations, burns, and soft part lacerations. This surgical group is the result of war and industrial accident.

The extent of the injury will naturally depend upon the agent inflicting the injury and whether the bony skeleton or the soft parts are involved, whether the solid organs such as the liver or kidney are torn, or the hollow viscera such as the stomach and intestines are perforated or ruptured.

DEFORMITIES

These may be divided into two big classes: those a patient is born with, and those which a patient acquires during life. Among some of the congenital deformities may be mentioned spina bifida, a condition in which part of the bony portion of the spinal canal is missing, harelip (Fig. 7), cleft palate, horseshoe kidney, six fingers, an extra arm, or the fusion of two individuals as in the case of the Siamese twins. Acquired deformities may be the

results of injuries which have been improperly treated, such as a poor reduction of a fracture, or from paralysis of muscles due to nerve injuries which cause such conditions as drop wrist or drop foot.

NEW GROWTHS

New growths, neoplasms, or tumors, may be defined as "growths, non-inflammatory in character, arising from pre-exist-

Fig. 7.—Hare Lip in an Infant.
(Courtesy of Dr. Edward D. Truesdell.)

ing tissue but independent of the normal rate or laws of growth of such tissue, subserving no physiological function." They may be classified as benign and malignant. *Benign growths*, as a rule, are localized; they may be excised without danger of recurring, and they do not spread to other parts of the organism and start new tumor formations. Examples of these are fibromas, lipomas, and cysts. They rarely endanger the life of the individual. *Malignant growths* are those which are not localized, which infil-

trate tissues and which spread to various parts of the body (metastasize). They are the cancers and the sarcomas. Surgery attempts to remove these with the knife. And those cells which have escaped the knife will start foci for the regeneration of new tumor tissue unless they are killed by the destructive action of subsequent radium and X-ray treatment. (Chapter XII.)

CHAPTER II

SHOCK AND HEMORRHAGE

SHOCK

Shock has been defined as "a state of profound mental or physical depression consequent upon severe physical injury or an emotional disturbance." It is certainly one of the most serious conditions facing the surgeon and the nurse, and the problem of its prophylaxis and treatment has not been entirely solved.

There are many theories of the etiology of shock, but its exact mechanism does not concern us here. It is always associated with a persistently low blood pressure resulting in a cerebral anemia, a contraction of the systemic arterial system, and a dilatation of the vessels of the splanchnic area of the abdomen.

Causes and Symptoms of Shock.—Mild shock, of course, may be psychic and finds its expression in ordinary fainting spells, but moderate or severe shock invariably accompanies all severe crushing injuries or fractures, prolonged or extensive operations, and severe hemorrhages. Shock is characterized by a rapid, thready pulse, a persistently low blood pressure, a pinched drawn face, sweating, and rapid shallow respirations.

Prophylactic Treatment of Shock.—There are several factors which aid in the prophylactic treatment of operative shock. A patient who is to be operated should be kept in a happy and cheerful frame of mind. He should have a good night's rest before his operation and his tissues should be well supplied with water. The latter can be easily accomplished by encouraging the drinking of fluids in copious amounts. Of course, two hours before operation no more water should be permitted. During the transport to the operating room, the patient should be warmly clad, and when placed upon the operating table, should be covered sufficiently so that a cold will not be contracted.

The technic of the operation is of prime importance. As little as possible of the abdominal contents should be exposed at a

time, and the exposed parts should be protected with moist, hot saline pads. The tissues should be handled gently, the hemostasis should be perfect, and the operation should be performed as speedily as is consistent with safety. Meanwhile, the patient should be kept under deep surgical anesthesia, the choice of the anesthesia being dependent upon the condition of the patient.

Inasmuch as all surgical procedure is associated with a continuous discharge of nervous energy from the operative field resulting in more or less shock, some surgeons supplement general inhalation anesthesia with local anesthesia. The theory is that the local anesthesia will block the impulses coming from the wound, and the shock will, therefore, be lessened. This general plan of *anoci association* is used quite extensively in several large surgical clinics.

Morphine.—After operation, it is customary to administer *morphine.* There is no other drug in the armamentarium of the surgeon as important or as useful as is this one. The first and most important duty of any doctor is to relieve pain, and this drug does it most effectively. Moreover, in this way, impulses are inhibited which reflexly might cause a general depression of the nervous system resulting in shock. Morphine is administered hypodermatically in quarter-grain doses with 1/150 atropine sulphate and repeated as often as the surgeon deems it advisable. The nurse, however, should always be mindful of its toxic effects, and if the respirations are unduly slowed and the pupils "pin-point," no time should be lost in reporting to the surgeon.

Treatment of Shock.—When a condition of shock is evident, it must be treated energetically and radically, and all efforts should be directed to raise the blood pressure. This may be accomplished by posture, the application of heat, and the administration of fluids, occasionally combined with certain drugs which elevate blood pressure.

The patient should be placed flat in bed with the foot of the bed elevated on medium sized shock blocks. This *shock position* naturally will encourage cerebral engorgement. Heat is applied externally by the use of warm blankets, electric pads or hot water bags, but every precaution should be employed to safeguard semi-stuporous or unconscious patients against burns. Measures to increase blood volume are quite efficacious not only

in raising blood pressure but in supplying water to a partially dehydrated system, inasmuch as the oral administration of fluids is curtailed after operation.

The methods of choice of fluid administration are largely dependent upon the urgency and the type of operation performed. If it is not urgent, it may be given by (*a*) rectum (provided there is no contraindication); if moderately urgent, by (*b*) hypodermoclysis; and if urgent by (*c*) infusion.

(*A*) **Rectal Administration of Fluids.**—Fluid, either tap water, saline, 5 per cent. glucose, or 5 per cent. sodium bicarbonate, may be administered by (1) small retention enemata, or (2) Murphy drip or proctoclysis.

(1) (*a*) *Retention Enemata:* These are quite practical, especially in children, for whom the Murphy drip is often impractical. As a rule, in adults six to eight ounces of warm fluid is given every six hours; in children the amount is much less.

(*b*) *Stimulating Enemata:* These are quite useful in conditions of shock, and are really retention enemata to which have been added stimulants such as coffee or whiskey.

(2) *Murphy Drip:* This is the administration of fluid by the rectum via a catheter, allowing the fluid to drip in at the rate of about sixteen drops per minute. It should be remembered that the fluid must be given slowly, for a Murphy drip never must be expelled. It is only natural, however, that when the tissues become plentifully supplied with fluid the rate of absorption will be lessened, and eventually the rectal mucosa will become so irritable that any attempt to continue this method will become futile. It is usually advisable to interrupt the administration of fluid by rectum at least every four hours, permitting a free interval of at least two hours before the treatment is resumed.

(*B*) **Hypodermoclysis.**—The administration of fluid under the skin, either beneath the areolar tissue of the breasts or into the thighs, while slightly painful, is an efficient method of fluid administration (see Fig. 60). It should be given in 500 c.c. amounts slowly, the nurse being careful to massage the accumulating fluid gently into the surrounding tissues. Saline is usually the only fluid which subcutaneous tissues will tolerate well, although some surgeons prefer the injection of diluted solutions of glucose. In cases of severe dehydration in which repeated injections might be necessary, it is advisable to employ "continuous hypoder-

moclysis." It is possible in this way to administer fluid continuously for 72 hours or longer. It must be given slowly and watched constantly, and the patient should be duly cautioned against tampering with the needles. Needless to say, the strictest asepsis is required.

(*C*) **Infusions.**—This is a rapid method of increasing blood volume by the administration of sterile solutions through any of the superficial veins (see Fig. 60). In adults, the median basilic at the elbow is invariably the most accessible. In babies, in which the veins are quite small, the superior longitudinal sinus may be chosen, and in young children the external jugular vein in the neck may be used. Normal saline in amounts from 500 to 700 c.c. may be given at 105 degrees F., or glucose 5 per cent. or sodium bicarbonate 5 per cent. may be given, especially in conditions of acidosis. If the blood pressure of the patient is quite low, an infusion may be administered continuously for as long as three or four days, and if the patient is in severe shock, 30 m.m. of adrenalin hydrochloride 1-1000 added to 500 c.c. of saline is often quite helpful. The administration of a continuous intravenous treatment requires constant attention. The rate of flow of the fluid must be carefully regulated. Its temperature must be kept constant, and not only does the arm have to be inspected from time to time to see that it is not becoming infiltrated, but the fluid level in the container must be constantly inspected to make sure that the needle has not become plugged with clotted blood. The arm is usually rendered immobile by placing it on an arm board in full extension. If the heart action should become embarrassed by too large a quantity of fluid, or kidney function impaired by too great an administration of salt, the infusion should be stopped immediately. It is important to chart the fluid intake and output at all times.

Probably the best intravenous medium is blood, for not only does it supply fluid, but it is really an "internal meal."

TRANSFUSIONS

Since hemorrhage may be partially responsible for shock, the imperative need often is to supply the blood which has been lost. Blood transfusions no longer present the obstacles which they formerly did, for the long tedious surgical methods of arteriovenous anastomosis have been practically replaced by the use of the syringe and its modifications.

Grouping for Transfusions.—Before any transfusion is given, it is always necessary to ascertain the blood group of the patient and of the "donor," because if bloods of different groups are mixed together the red blood cells are destroyed and the patient is liable to suffer a very severe reaction, and derive no benefit from the treatment. Human bloods are divided into four groups. Of these the largest are groups two and four which together constitute about eighty-three per cent. of all individuals. In selecting a "donor," it is very important that he be in good physical health and that his blood be high in hemoglobin and free of syphilis as evidenced by a negative Wassermann reaction.

Methods of Transfusions.—Transfusions may be given by one of three methods,—the direct arteriovenous method; the indirect, as represented by the syringe method; and the one in which sodium citrate is used. The anastomosis of an artery of a donor to a vein of the recipient is no longer done, because this rather cumbersome method (which was rarely very successful) has been replaced by the other two types, which are more efficient, certainly easier of operation, and less trying both to patient and donor. The syringe method first used by Lindeman employs glass record syringes which draw the blood from the vein of the donor; the freshly drawn blood is then immediately injected through a needle into the vein of the recipient. The great disadvantage is the fact that the blood is apt to clot in the needles of the syringes in spite of the fact that these instruments may be flushed with saline during the procedure as is done in the Unger method. To overcome this obstacle, a method frequently used at the present time is the Lewisohn transfusion. It has been demonstrated that chemically pure sodium citrate in solution will prevent blood from clotting, and if used in a strength not exceeding two-tenths per cent. will not prove injurious to the patient. The usual procedure is as follows:

The donor is bled into a flask containing enough sterile sodium citrate solution to prevent clotting, and as the blood flows from the vein of the donor into the glass container, it is slowly shaken so as to insure complete mixing with the citrate. The drawn blood, now rendered uncoagulable, may be given at once, or, if it is not practical, it may be kept on ice and used any time within twenty-four hours, provided it is warmed to the body temperature before injection. As a rule, the blood is given to

the recipient by the "gravity method." This permits it to flow by gravity from a container elevated about two or three feet above the head of the patient into the vein of the recipient through the ordinary Luer needle which has previously been inserted. Or, it may be given by the gravity method plus a three-way stop-cock and Luer syringe. The blood flows from the container into the syringe. When this is filled the cock is turned and the syringe emptied of its contents by piston pressure, the blood passing into the vein. Then the stop-cock is turned again and the syringe refilled. This technic is elaborate but there are no real advantages over the gravity method. (The apparatus used is the same as for any saline infusion; it should be boiled in distilled water.)

But there are several features which need extra care; for example, if new tubing is to be used, it should be soaked in a one per cent. solution of sodium hydrate for 24 hours, then in distilled water for the same length of time, and following this, it should be sterilized by boiling in distilled water. It is exceedingly important after any transfusion that all parts of the apparatus be separated and that the tubing, glassware, etc., be washed with cold tap water. They then should be soaked in sodium hydrate for one-half hour, in distilled water for another half-hour, and each part, especially the needles, should be carefully examined for remnants of very small particles of blood. The needles should be cleansed with benzine, ether and albolene and the tubing should be dried well. After the glassware has been dried, it should be wrapped in a towel and then in a blanket and autoclaved for 25 minutes at 15 pounds pressure.

After Treatment.—Following some transfusions there is apt to be a reaction manifested by chills and fever and sometimes nausea and vomiting. The nurse should always be prepared for this emergency. This may occur from ten to twenty minutes after the transfusions, and the treatment is the same as for any chill,—blankets, hot bottles and a little brandy, if permitted. It is advisable to save the urine of all these cases because it should be examined for the presence of altered blood. This will indicate whether the recently given blood has been of value to the patient, or whether it has been destroyed and is being eliminated by the kidneys.

HEMORRHAGE

Hemorrhage is any bleeding, especially of a profuse nature. It may be either *arterial*, *venous*, or *capillary*. It may be external or internal. An external arterial hemorrhage is recognized by a stream of blood which is bright red, and spurting, each spurt corresponding to a cardiac systole or a contraction period of the heart. Venous bleeding is a slower, steadier stream of dark red blood. Capillary bleeding is evidenced by simple oozing.

Causes of Hemorrhage.—*External hemorrhages* may result from injuries in which vessels are divided accidentally or in the course of operative procedure. Occasionally a superficial varicose vein may bleed following an ulceration, or a slough in a wound may open a vessel.

Internal hemorrhages may follow intra-abdominal injuries in which vessels are torn by crushing blows or divided by bullets or other weapons. Ulcerations often erode internal blood vessels as occur quite frequently in gastric or duodenal ulcers. In this disease the patients may vomit blood (hematemesis) or pass tarry stools (melena). A fairly frequent cause of intra-abdominal hemorrhage is that of a rupture of a Fallopian tube in an ectopic pregnancy. After any abdominal operation, secondary hemorrhage is possible due to a poorly tied ligature slipping from a large vessel.

Symptoms of Hemorrhage.—If the bleeding is external, the hemorrhage is recognized rather readily and is usually easily controlled. But if the bleeding is internal, it may be moderately difficult to diagnose. There are certain symptoms, however, which are rather important to recognize. As a rule the face is pinched, there is a marked pallor of the conjunctiva, and the skin is cold and clammy. The pulse is rapid and thready, and the blood pressure is low. The respirations are superficial and shallow and increased. In fact, air hunger is a diagnostic sign of hemorrhage, and it is this which distinguishes it from shock. In the latter condition, the patient is ordinarily quiet, somewhat depressed. In hemorrhage, the patient is restless, gasping for breath, asking to have the windows open, begging for more air, and feeling as if he were being smothered. However, it must not be forgotten that the majority of cases of hemorrhage are invariably associated with shock.

The Local Treatment of Hemorrhages, Arterial and Venous.

—If a large artery or vein has been cut, the first aid treatment is to arrest the hemorrhage by simply obliterating the vessel by applying pressure through a tourniquet. This is a circular band made of any material, placed about a limb and tightened until circulation through the vessel is stopped. It is an excellent method for the arrest of hemorrhage until medical aid can be summoned and the vessel clamped and tied. However, no tourniquet either in an emergency or during an operation should be left in place for more than one hour because gangrene of the extremity either in part or its entirety is apt to ensue if the limb is deprived of its blood supply for too long a period of time.

Ligature: After the bleeding vessel has been grasped with artery forceps, its lumen is permanently obliterated by tying with a material which may be absorbable, as catgut, or nonabsorbable, such as silk or linen. Occasionally for technical reasons, or the poor condition of the patient, the artery clamps may be left in place and no attempt made at ligation. After several days when thrombosis has taken place, the clamp may be removed without fear of hemorrhage. If the vessel is moderately small and has been caught in an artery clamp, hemostasis may be secured by twisting the arterial wall by turning the clamp. This method is known as *torsion.*

The Local Treatment of Capillary Bleeding.—There are various ways in which oozing can be controlled, depending largely upon the location of the bleeding and the type of tissue involved. For example, after the removal of adenoids and tonsils, or operations upon the nose or pharynx, bleeding is often controlled by slapping the face and neck with ice-cold water. It appears that the contraction of superficial vessels leads to a reflex contraction of the deeper ones, thus stopping the hemorrhage. An ooze from a deep cavity such as is left by the removal of a prostate gland may readily be controlled by packing the cavity with dry gauze, or gauze soaked in thromboplastin, a chemical used to aid the clotting of blood.

Bleeding incurred from the curettage of a granulating surface preparatory to skin graft is controlled quite effectively by the pressure of hot moist pads or towels. The ooze from brain tissue is stopped in much the same manner except that gentle pressure is exerted by cotton sponges moistened with hot saline.

Bone hemorrhage in which packing is impractical is effectively controlled by plugging the bleeding vessel in the medullary canal with Horsley's wax. This is composed of seven parts beeswax, one part almond oil, and one part salicylic acid. Bleeding from the stomach may be controlled by lavage with ice water, but an ice water douche in a hemorrhage from a uterus might result in shock. Instead, a sterile intra-uterine douche with a little acetic acid in water of 110 degrees to 115 degrees is excellent. It may be necessary to supplement this with packing either with plain or medicated gauze. In bleeding from ulcerating carcinomatous tissue, very often the only way to arrest the hemorrhage is to apply either the actual or electric cautery, which coagulates the tissues and stops the bleeding. For small pin-point oozing, styptics, astringent agents such as silver nitrate and copper sulphate are quite effective when applied directly to the bleeding point.

The Treatment of Internal Hemorrhage.—This depends largely upon the degree and the source of the hemorrhage. It may be conservative or operative. If in a traumatic case, for example a rupture of the liver or a partial rupture of the spleen, the surgeon feels that the hemorrhage has either lessened or ceased, he may simply order morphine, the ice coil or cold applications to a particular region of the abdomen and possibly administer 10 c.c. of a five per cent. sodium citrate intravenously, which some claim has yielded excellent results in causing clotting. However, if the patient is suspected of active bleeding, especially intraperitoneally, no time should be lost in an exploratory operation. The source of the hemorrhage should then be ascertained, and the bleeding vessels ligated. Occasionally, however, the patient is in such wretched condition that a small transfusion must be administered before operation is possible. After the hemorrhage has been controlled, it is important to supply the body with fluid, either with blood or saline. If shock is present, the various measures already suggested should be energetically employed.

CHAPTER III

POST-OPERATIVE COMPLICATIONS

The operation completed, the surgeon has done the major part of his work, and the patient from then on is entrusted to the care of the attending nurse. It is true that all orders are given by the attending surgeon, but their conscientious execution is dependent upon the integrity and efficiency of the nurse. The surgeon may see the case but once a day; the nurse sees the patient at all times; and she, by her careful attention to details and her knowledge of human nature, can do much to make the patient comfortable and the post-operative course smooth in spite of the many complications which might arise. The immediate care of the patient after leaving the operating room is discussed in Chapter XIV. It is the purpose of this chapter to discuss the treatment of the various post-operative complications. The most important of these are nausea, vomiting, pernicious vomiting, gastric dilatation, tympanites, auto-intoxication, post-operative pneumonia, pulmonary embolism, urinary retention, urinary suppression, phlebitis, thrombosis, and hemophilia.

NAUSEA AND VOMITING

These are usually present after all operations for a short time. Some doctors are in the habit of ordering cracked ice to relieve this distressing symptom. Whenever it is ordered, care must be taken lest the patient get too much and in this way imbibe large quantities of cold water with the result that vomiting is very apt to ensue. When the feeling of nausea becomes very severe it is accompanied by vomiting. If a patient vomits later than twenty-four hours after operation, there probably is something in the stomach which is causing a persistent irritation. Once this irritation is removed, the vomiting will generally cease. It must be remembered that the patient has just been operated upon, and

that the nerves are exhausted, and that conservative treatment is better than radical. The most effective procedure for ridding the stomach of foreign material is gastric lavage; but washing the stomach is trying and tiring and should only be employed when other simpler methods have proven unsuccessful. First the following should be tried:—A glassful or approximately eight ounces of lukewarm water with about a teaspoonful of bicarbonate of soda should be administered by mouth. As a rule, patients are very thirsty after operation, and avariciously drink the proffered water. The result is that they are further nauseated and soon vomit the ingested water, thus washing out the stomach, and instant relief often ensues. Sometimes, in spite of these measures, vomiting will still persist. It is due then to atony, a relaxation of the muscles of the stomach wall. Persistent vomiting is very weakening, and gastric lavage should be given almost immediately, if the bicarbonate of soda and water fail to afford relief. A post-operative lavage must be of hot water, for the heat itself is the efficient agent in stimulating the stomach walls to contract, and therefore the water should be introduced at about 108-110 degrees Fahrenheit. Another point,—as little air as possible should enter the stomach tube, and when the lavage is finished, the water should be carefully siphoned off from the stomach. If the vomiting persists after a good gastric lavage, it then may be due to either pernicious vomiting or possibly gastric dilatation.

Pernicious Vomiting.—This may occur in children as well as in adults, and is usually a manifestation of what is commonly spoken of as "acidosis," a condition in which the normal alkalinity of the blood is diminished. It is recognized by the sweet and fruity odor of the breath. If this condition be suspected, the urine should be examined for the presence of acetone. If it be present, gastric lavage should be given, everything stopped by mouth, and alkalis administered immediately either by a ten per cent. sodium bicarbonate solution in a Murphy drip, or intravenously in three to five per cent. solution, but never by clysis.

Sodium bicarbonate is given until it is excreted by the kidneys. When the urine is alkaline it is safe to assume that sufficient bicarbonate has been administered to bring the blood back to its normal alkaline reaction, thus reducing the acidosis

which is the underlying cause of vomiting in these particular cases. There is one point, however, which needs emphasis in the administration of sterile sodium bicarbonate solutions. After the desired solution has been compounded, it must be sterilized. Sterilization, by its heat, drives off carbon dioxide, thereby reducing the bicarbonate of soda to sodium carbonate. This compound is not as good as the bicarbonate because it is more irritating to the tissues, and is not as effective in reëstablishing the alkalinity of the blood. To counteract this, after the solution has been cooled sufficiently, carbon dioxide may again be added by connecting a sterile tube to a carbon dioxide tank and allowing the gas to bubble through the sodium carbonate fluid for a sufficient length of time, thus making a bicarbonate compound.

GASTRIC DILATATION

One of the most distressing complications which may arise after an operation, and one which, if not treated radically, energetically, and thoroughly may result in death, is acute gastric dilatation. As the name implies, in this condition the stomach becomes enormously dilated, and presses upward on the diaphragm. This makes respiration very difficult because of the constant pressure on the diaphragm. And, inasmuch as the pyloric orifice of the stomach is atonic, the intestinal contents seep back into the stomach, resulting in persistent vomiting of large amounts of greenish and brownish colored fluids. To relieve this condition those means must be employed which will cause the dilated stomach to contract and approach its normal size.

Treatment.—The stomach should be lavaged with a hot soda bicarbonate solution at 110 to 112 degrees Fahrenheit, and the lavage continued until the return is absolutely clear. While this treatment is under way, turpentine stupes should be applied to the upper abdomen for ten or fifteen minutes. It is important to bear in mind that as these stupes must be hot to be efficacious, the abdomen should be thoroughly greased with vaseline before applying them, as great care must be taken that the skin is not burned. The integrity of the skin must be preserved because this procedure is to be repeated every two or three hours, according to the discretion of the attending surgeon. The stupe probably is the most efficient and reliable method for applying

external heat, although some authorities advise the use of huge flaxseed poultices. Strychnine sulphate, gr. 1/60, may be given by hypodermic injection every four hours, following the principle that the strychnine will improve muscle tone.

The patient, of course, during this period, should be given nothing by mouth, but measures should be taken to supply the system with water. By persistent vomiting these unfortunate patients have desiccated themselves of fluid, and it is necessary that fluid be administered by means of a Murphy drip, or that eight ounces of tap water be given by rectum every four hours. If the patients show signs of shock, which they often do, a hypodermoclysis of 500 to 800 c.c. of saline should be given, or, in some instances, an infusion of saline. If nourishment be an essential element a solution (two to five per cent.) of glucose may be administered intravenously. The glucose may also assist in combating a beginning acidosis brought on by inanition.

Some surgeons, in order to save the patient the agony of repeated lavages, pass a *Levin tube* (similar to a duodenal tube) through the nose down into the stomach. This is left in place until the vomiting has stopped. The patient is then permitted to drink water and by syphonage the fluid plus gastric and intestinal contents runs out through the tube, thus washing out the stomach and keeping it continuously empty.

After the initial period of vomiting has come to an end, it is advisable to give the stomach an absolute rest for about twenty-four hours, and then to start the patient on what may be called a "gastric tolerance diet." The theory of this diet is to partially desensitize the mucosa of the stomach and make it more tolerant to fluids by the use of small doses of chloroform water. If this is retained, peptonized milk is then started in small doses. The amount of peptonized milk is then gradually increased, the chloroform water is omitted, and the patient, after a period of absolute gastric tolerance, is gradually brought over to a selected soft diet. The exact details of this diet are given in Chapter XIII on surgical dietetics.

TYMPANITES

The distention of an abdomen following operation is due to a gastric dilatation, a distention of the small or large intestine, or a dilatation of the bladder resulting from urinary retention.

The word tympanites or meteorism denotes an inflation of the abdomen with gas. This gas is usually intestinal; occasionally it may be free in the peritoneal cavity from a perforation of the intestines. A condition of gastric dilatation is recognized by distention in the upper abdomen; that of the small or large intestine, by a generalized abdominal distention; that of the bladder by palpation of a rounded mass just above the pubes and the failure of the patient to void after operation. Tympanites is certainly distressing and modern surgical nursing commands many methods to alleviate and relieve this condition, bringing much comfort to the patient.

Treatment.—The theory underlying all treatments is to aid the patient in ridding the small intestines and colon of gas. The means for accomplishing this are many. One of the simplest procedures and one of the most efficient is the introduction of a rectal tube.

Rectal Tubes.—These are small pieces of rubber tubing about three-eighths of an inch in diameter, rounded at one extremity. This is well lubricated with either K-Y or vaseline, and gently introduced into the rectum beyond the internal and external sphincters, and about three to four inches beyond the anus. The purpose is to form an exit for gas which may have accumulated in the colon. This simple procedure is often all that is necessary.

Enemas.—Especially in emergencies when the patient has not had a cathartic, or a thorough intestinal cleansing before the operation, the fecal material is apt to accumulate in the colon, causing fermentation and often stopping the passage of gas or flatus by its mechanical bulk. In these conditions it is important to empty the lower bowel by a cathartic enema. The soapsuds enema is usually all that is required. But in those cases in which the soapsuds have brought very little return, and the distention is still marked, and it is thought that fecal material is being retained, it is advisable to give a more purgative enema. The solutions which may be added to enemas may be glycerine, one ounce, or turpentine, ½ ounce to the pint. Milk and molasses—four ounces of milk and four ounces of molasses—make a good irritative enema. The magnesium sulphate enema is used now quite frequently—two ounces each of water, glycerine and magnesium sulphate in saturated solution being employed. Some

institutions use a mixture with oxgall in the following proportions:—turpentine ℥ ii, oxgall ℥ ii, magnesium sulphate ℨ iv, glycerine ℨ iv.

These purgative, irritative enemas not only empty the lower bowels, but also stimulate the smooth muscles to contract, thus expelling the gas which has accumulated. Irritative enemas for safety's sake should be small in amount. The soapsuds enema, however, made from Castile or Ivory soap, is given in amounts varying from two to four pints. After operation, it is best to give the enema in the dorsal position, putting the douche pan under the patient before the enema is given. The returns should be watched for the presence of fecal material, mucus, blood, bile, and gas. Enemas after operation should always be ordered by the attending physician, and no nurse should take upon herself the responsibility of injecting fluid into the rectum. As a rule, they should not be given in rectal cases, perineorrhaphies, or resections of the colon unless absolutely essential.

Colon Irrigation.—The colon irrigation performs three functions: It supplies a certain amount of fluid to a system which needs water; it carries off fecal material, and acts as a medium for the expulsion of gas. Colon irrigations when given properly should cause the patient absolutely no distress. If perfectly given, there is no reason why the patient should not fall asleep during the treatment. Many solutions are used for the irrigations. Normal or half strength saline is quite common, but it must be remembered that it increases the thirst of the patient, and for this reason, provided that the rectum will retain it, tap water is better. Any irrigation to be effective must be given hot, at a temperature varying from 110-120 degrees. About three gallons should be used for a single irrigation. While the technic of giving an irrigation is known to every nurse, there are a few points which might be emphasized, and which if remembered, will cause greater comfort to the patient. They are as follows:

1. All air must be expelled from the inflow catheter before it is inserted.

2. The catheter should be inserted within the outflow tube so that only one tube is inserted into the rectum.

3. The end of the outflow tube should not be more than a foot below the level of the patient. If it is, a jerky interrupted

flow is apt to result because too great a suction is established, and the mucous membrane of the rectum is apt to be drawn about the holes of the rubber tubing.

4. There should always be a return of fluid through the outflow and if for any reason it is not evident, the irrigation should be stopped immediately. For the pressure of fluid through the inflow tube might be so strong as to cause distention with a resulting paresis of the gut; or, what is extremely rare, there might be a perforation in the colon through which fluid empties itself into the peritoneal cavity. The amount of fluid which the patient absorbs can easily be estimated by comparing the amount given and the amount returned.

There are two ways of giving a colon irrigation:—one way is to use an inflow and outflow tube; the other, one tube to serve alternately as inflow and outflow. The second method is less advisable, for it is more like an intermittent enema, and is certainly more uncomfortable to the patient.

Aids to Colon Irrigations.—Just as in a dilatation of the stomach water is applied internally and heat externally by the application of poultices, so, in giving a colon irrigation, to make it more effective, and to aid in stimulating the contraction of the smooth muscle of the bowel, large flaxseed poultices are used for their counter-irritative effects. In addition, very often 1 c.c. of pituitrin is given intramuscularly during the colon irrigation. It is a known fact that a substance in the posterior lobe of the pituitary stimulates smooth muscles to contract. Pituitary extract should not be given by mouth because its administration in that manner is practically ineffectual. In some cases, fortunately rare, rectal tubes, enemas and colon irrigations will not relieve abdominal distention. These cases are spoken of as *paralytic ileus.*

This is a condition in which the smooth muscle of the intestine is practically paralyzed; there is no peristalsis, no passage of gas, the patient becomes more and more distended as the fermentation becomes greater and the toxemia becomes more severe. This condition is helped by immediate surgical interference alone. The mortality, however, is terrifically high. The operation performed is an *enterostomy* (Chapter V, page 85); an opening is made in the small intestine through which the gas, fluid and solid material may escape. Thus with a diminution of

the degree of toxemia, the intestines, relieved of their burden, will have sufficient strength and recuperative powers to regain their normal tone and peristaltic wave action.

AUTO-INTOXICATION

Closely allied to meteorism is auto-intoxication. In this condition, especially in children, the patient absorbs certain products of fermentation and decomposition from the gastrointestinal tract, resulting in a slight degree of temperature usually associated with headache and general malaise. This is ordinarily relieved by a movement of the bowels, procured by an enema and a cathartic. This condition is never very serious, and never alarming.

POST-OPERATIVE PNEUMONIA

This is one of the most serious of post-operative complications. Often a patient reacts favorably to an operation only to be dragged down in a day or two by the toxemia of lung involvment; and this, together with the general weakness following surgical interference, often results in death. While pneumonia cannot be absolutely obviated as a post-operative complication, there can be a marked diminution in its frequency if greater attention is paid to the smaller details of ante-operative and post-operative care.

In hospital work and in private nursing the fact is often forgotten that the patient in his home has been accustomed to certain clothing and has been living for years under peculiar hygienic conditions. Upon entering the hospital he is given an abbreviated nightgown and placed in a bed with one or two blankets. When he is physically examined his gown is taken off, and very often there is a draught from a nearby open window. The deep breathing and coughing incident to the auscultation of the lungs often cause a perspiration, and the cool air on the heated skin is a poor combination. Occasionally the patient is asked to get out of bed and stand up, his bare feet very often resting against the cold floor; or often, when the abdomen is shaved and being prepared for operation, the patient is unduly exposed. Then from a warm bed he is placed upon a cold stretcher, wheeled through draughty, chilly halls, and plunged into a superheated operating room. During the opera-

tion he is apt to perspire freely, and while it is routine to change a drenched gown, the patient, through neglect, is often permitted to keep it, and in this condition he is sent through the halls again, back into the ward. During the recovery period, he may toss around, uncovering his body, and exposing his depressed system to more draughts, more chilling, opening the way to a pneumonia. When the matter is given thought, the real wonder is that pneumonia is not more frequent. The best method of treating this serious complication is by prophylaxis. Prevention is better than cure, and careful and conscientious surgical nursing will greatly aid in diminishing the incidence of this dreaded complication.

Prophylactic Treatment.—*Ante-operative.*—All patients before operation should be carefully examined for coryza, bronchitis, pharyngitis, or tonsillitis, and if any of these exist, the operation should not be performed, but temporarily postponed. Of course, acute cases fall into another category, and very often it is advisable to do these under local anesthesia rather than run the risk of ether or gas administration which is sure to spread the infection into the lungs. If the nurse at any time prior to operation notices that the patient sneezes excessively, or that signs of a cold are developing, it is imperative that she immediately notify the surgeon, for few will operate when there is even the slightest infection of the respiratory system.

When patients are being examined physically, or receiving treatments, it is highly important that all windows and doors in the vicinity be closed and that draughts be diminished to the minimum. If a patient has to leave the bed he should be adequately supplied with slippers, a bathrobe, and, if necessary, a blanket. When he is moved to and from the operating room he should be warmly covered, and in the operating room the same general rules hold true. If his gown becomes wet with perspiration, his body should be thoroughly dried and a new gown supplied.

Operative Prophylactic Treatment.—While the patient is recovering from the anesthetic, the lower jaw should be held firmly and pressed forward, exerting pressure at both angles; this will do much to prevent gagging. When the patient vomits, the head should be turned to one side, the jaw still being held, and the vomitus eructated into a pus basin. It is highly important

that this be always done, because if this procedure is routinely and regularly followed, the danger of the vomitus being aspirated into the lungs is reduced. Aspiration is not an uncommon cause of pneumonia.

Post-operative Prophylactic Treatment.—When the patient arrives in the ward or room he should be warmly covered, and very often in order to maintain a good body heat, the bed may be previously warmed either with electric pad or hot water bottles. If the patient tosses about, the blankets should always be readjusted.

If there is a tendency to vomit, the jaws should be held firmly forward and the head turned to one side so that there is no chance of aspirating any vomitus. It is extremely important to encourage all patients who have had abdominal operations to breathe deeply so that the lungs will be completely aerated, thus diminishing the chances of hypostatic congestion. Some surgeons require these patients to indulge in deep breathing exercises by blowing fluid from one bottle into another. In other words, the incidence of post-operative pneumonia may be greatly reduced if the patient is free from respiratory infection before operation, and if during the period of surgical treatment he is adequately protected from draughts and unusual and sudden changes of temperature.

Treatment of Post-operative Pneumonia.—The treatment is really that of any lobar pneumonia. The patient is usually on a Gatch bed. The Gatch bed is one which is made in sections so that the upper portion of the body may be elevated and the knees flexed by adjusting these sections to any desired degree.

The windows are opened wide and as much fresh air is given as is possible. The diet is liquid, including milk. Fluids should be forced to about 3,000 c.c. a day, and the intake and output should be accurately measured.

Abdominal distention is always looked for and treated immediately with rectal tube, enemas or colon irrigations.

The cough is particularly distressing and dangerous, for after a surgical operation the pressure caused by straining may break some of the sutures and sometimes the abdominal wound is ruptured wide open, and the abdominal contents eviscerated. To prevent this horrible complication a good, tight, well-placed binder is exceedingly important, for it gives added support to

the abdominal wall. If the coughing is very severe, the nurse should support the lateral areas of the abdominal wall with her hands. Should evisceration take place, the intestines should be covered with sterile towels, and the surgeon immediately summoned. For the cough, doctors will prescribe a codeine cough mixture, or leave orders for codeine to be given either by mouth or hypodermic.

As soon as the diagnosis is made it is routine to administer tincture of digitalis as a cardiac stimulant. The patient may be given large doses of the tincture in order that he may become rapidly digitalized or he may be given 10 to 15 m.m. of the tincture three times a day. If the pulse is very rapid and the heart overacting, some relief may be obtained by placing an ice bag over the precordium.

Pleural pain, which is very distressing, yields to strapping the affected side with adhesive plaster.

Pneumonia cases must always be watched carefully for cardiac failure and edema of the lungs. The cardiac failure is evidenced by a weak, thready pulse, cyanosis and respiratory difficulty. Edema of the lungs manifests itself by bubbling respirations.

Cardiac failure is treated by stimulants, such as camphor in oil, caffeine, or atropine. Edema of the lungs responds best to good dry cupping especially applied to the posterior regions of the chest. This should be done for about twenty minutes at a time. Great care should always be exercised in preventing the patient from being burned with the cups. The use of oxygen in these cases with the present apparatus is practically useless and worthless, although some excellent results have been reported by using the oxygen tent.

PULMONARY EMBOLISM

Closely allied to post-operative pneumonia, but of different etiology, is pulmonary embolism. It is not very common, and may occur after the simplest operations; for example, after an appendicectomy, or an operation for varicose veins; it may be preceded by a thrombosis of the veins of the lower extremity, or come as a distinct entity. As a rule, it is ushered in by a sudden pain in the chest, dyspnea, bloody expectoration, rapid pulse, and slight rise in temperature. If the chest is auscultated the doctor may sometimes note a friction sound, or signs of begin-

ning pneumonia may be evident. Occasionally, instant death occurs, and at best the mortality is high, varying from seventy to eighty per cent.

Treatment.—Patients who develop a phlebitis or thrombosis of the veins of the lower extremity, or any other region, should be kept in bed until this condition absolutely subsides, because a small piece of blood clot may break off and lodge in the lung as an embolus. Patients should not be permitted to be too active after operation even if their condition is excellent. The treatment of embolism is to reassure the patients, for they are apt to become greatly alarmed at the sight of their bloody expectoration. To further quiet them morphine is administered. If the diagnosis of its location is made, it is customary to strap that side of the chest in which the embolus is lodged. This will immobilize the affected lung as much as possible.

The family of a patient suffering from a pulmonary embolism should be apprised of the impending danger, for even though the patient may recover from the shock of the embolism itself, it may give rise to an embolic pneumonia and a recovery from this condition is exceptionally rare although it occasionally occurs.

URINARY RETENTION

After operation, occasionally, a patient is unable to void urine voluntarily with the result that the urine collects in the bladder, the organ becoming dilated beyond its usual capacity. Pain is very apt to result from this distention, and the patient is very uncomfortable. Urinary retention is more prone to occur after operations about the rectum, the vagina, the cervix, and the bladder itself than after operations involving the upper abdomen. The reason for this is that the center of micturition has been reflexly inhibited by the operative procedures; or it may be due to nervousness or to conscious control not having as yet been reëstablished after the administration of an anesthetic. As a rule, no patient should be allowed to go more than twelve to twenty hours without voiding. However, every effort should be made to have the patient void voluntarily, because all functions are better performed by nature than if mechanically aided.

Treatment.—The treatment of urinary retention is catheterization. A catheterization is a surgical procedure. A surgical

procedure in clean cases is an aseptic one, and every bladder which becomes infected after the introduction of the catheter is a horrible reflection upon the individual who has done the catheterization. This procedure should be done with a good light. The urethral orifice is carefully exposed and adequately cleansed. The catheter, be it rubber, metal, or glass, should be lubricated with a sterile oil, either olive oil or K-Y. The urine which is withdrawn should be saved and examined as a matter of record. While catheterization every eight hours is a routine in some hospitals after perineorrhaphy, it should be remembered that a patient may develop a "catheter habit" because the act of micturition or urination causes slight pain, and catheterization affords instant relief without pain. These cases should be treated firmly but gently and various expedients should be tried to induce voluntary micturition. The drinking of large quantities of water, the sound of running water from turning on a water faucet within hearing distance of the patient, pouring warm water over the vulva or changing the position in bed is all that may be necessary to encourage voluntary micturition.

In those cases where there is an old inflammation of the bladder, it is advisable not to draw off all the urine at once, but to leave about four ounces in the bladder, or if all the urine is withdrawn, to introduce immediately into the bladder about four ounces of a warm sterile solution of boric acid. This will prevent any possibility of an infection traveling from the bladder to the kidneys via the ureter. The details of catheterization are not given here, as they are known to every nurse, but it cannot be emphasized too strongly that this treatment above all must be done by a nurse with a surgical conscience.

SUPPRESSION OF URINE

Following some of the more extensive major operations, especially those upon the kidney, either a nephrectomy or a nephrotomy, or prostatectomy, the kidneys may shut down and secrete no urine; the result is, that those substances which should be normally excreted in the urine as the urea, are stored up in the blood. There is, however, a limit to the amount of nitrogenous poison which the blood can contain, and if this threshold is crossed, the patient may suffer from uremic poisoning. Uremia is recognized by the urinous odor of the breath, the dried parched

tongue, a semicomatose attitude of the patient, the urinary suppression, and an increase in the nonprotein nitrogen of the blood.

Treatment.—The prognosis in all these cases is poor. The same methods used by medical men in combating uremia resulting from diseased kidneys are used by the surgeon. If the kidneys are incapable of physiologically performing their function of elimination, then for the time being other organs must take over that function. There are many adjuvants,—the sweat glands of the skin and the intestinal canal are invaluable aids. The reflex stimulation of the kidneys by counter-irritants, the forcing of fluids so as to dilute the poison in the blood, the actual removal of some blood with its poisons (phlebotomy), and, finally, operation upon the kidney itself, all help in this very serious complication.

The *skin* may be used to further aid excretion. If the patient will stand it, hot packs should be employed. The purpose of a hot pack is to cause perspiration, and inasmuch as urea is one of the chief elements of sweat, a partial strain is taken away from the kidneys. Very often this procedure alone will be sufficient to stimulate the kidneys to excrete urine. Hot packs should be repeated at intervals of four to six hours. While the treatment is being administered, the condition of the patient must be carefully watched, for the packing often results in weakness and prostration. The other danger of giving a pack to a surgical patient is that the body must be carefully dried after the treatment in order to prevent post-operative pneumonia. In addition, great care should always be taken that the skin (which has already been made sensitive through the application of the ante-operative painting of iodine) should not be burned, and further avenues of infection opened through denuded skin.

The use of the *intestinal tract* as an avenue of elimination may be further stimulated by employment of colon irrigations. The colon irrigations, as stated previously, not only carry off large amounts of toxins, but they are a means of supplying water to the tissues.

The *kidneys* may be stimulated reflexly by counter-irritants applied to the skin of the lumbar region. This may be accomplished by the use of flaxseed poultices applied at two-hour intervals, or by hot water bottles. Some surgeons employ drugs

in order to stimulate the kidneys directly, by the use of such substances as theobromine because of its direct diuretic action. Five to eight grains are given three times a day for the space of three days and then the drug is stopped. There is no doubt that this drug is excellent in stimulating the kidneys and certainly surpasses caffeine in its action. The disadvantage is that it might cause a certain amount of nervousness and insomnia.

Forcing fluids either by proctoclysis or hypodermoclysis will cause enough fluid to be absorbed to dilute the blood, thus resulting in a diminution in the degree of toxemia. This simple method not only relieves the patient of an impending uremia, but the kidneys are stimulated by the added amount of fluid.

In cases of high blood pressure with a high blood urea, the actual removal of part of the blood volume will do much to reduce the nitrogen content of the blood, if only for a short period of time. This is done by a *phlebotomy*, or inserting a cannula in a vein in the arm, and permitting the patient to be bled of 250 to 700 c.c. of blood. The amount withdrawn should depend upon the constitution and physique of the patient. Quite often after this procedure, 250 to 500 c.c. of normal saline are introduced intravenously, resulting in further dilution of the toxins.

If, in spite of all these procedures, there is no urine excreted, a rather heroic operative procedure may be resorted to, that of decapsulating the kidneys. This is especially indicated in those cases which have a chronic inflammation of the kidneys, pre-existing Bright's disease. The operation is spoken of as Edebohl's decapsulation.. It consists of the excision of the capsule from the kidney so that with this restraint removed, the organ may be able to work more efficiently by establishing new vascular relationships with the surrounding tissues, thereby obtaining better nourishment for itself.

PHLEBITIS

This condition is an inflammation of the veins, usually of the lower extremity. It is rather late in onset and is annoying because the patient is confined to bed for a longer period of time. It is manifested by cramp-like pains in the leg, a rise in temperature, and a feeling of general malaise. Examination of the affected extremity shows that the part is swollen and the skin over the veins reddened. Occasionally the veins may be pal-

pated. The treatment calls for absolute rest, elevation of the affected part and immobilization, the part being kept warm by a wrapping of cotton, or the additional heat of an electric pad. Phlebitis may be associated with or followed by thrombosis.

THROMBOSIS

This may follow in the path of a phlebitis, and simply means the occlusion of the lumen of the vein with a blood clot. The same condition may occur in arteries. The symptoms are practically those of a phlebitis. The danger of these cases lies not so much in thrombosis itself, but the fact that these thrombi may give rise to small particles of blood clots (emboli) which invade the blood stream and localize in any part of the body. The symptoms and physical signs depend on the area in which these emboli have lodged. If it should localize in the brain, paralysis might ensue; if in the central artery of the retina, blindness; if within the coronary artery of the heart, immediate death. A glance at these possibilities is certainly proof that a thrombosis is potentially a dangerous operative complication.

Treatment.—The acute condition is treated practically the same as a phlebitis, with the exception that the local applications vary, some using ice compresses over the veins, others a 20 per cent. ichthyol ointment, some the electric pad. All surgeons believe in absolute rest of the part involved. It is a good practice to keep the weight of the bed clothing away from the affected area, by means of a wooden or metal cradle. When all the acute inflammation has subsided, the patient should not be allowed up and out of bed until a good firm pressure bandage has been applied. In a leg case, the bandage is wound from the ankle upward to the knee. The patient should be warned that even after leaving the hospital, or home, a rubber stocking properly fitted should be worn for a long period of time.

Of course when this condition involves the superficial veins it is not so very serious, but it has been known to choke off the femoral artery, the main channel through which the lower extremity gets its supply of blood. This might result in gangrene with subsequent amputation of the leg and thigh. These severe post-operative complications are fortunately rather rare.

HEMOPHILIA

As science progresses new discoveries are made and some certain operative complications may be prevented by prophylactic measures. A disease no longer dreaded is hemophilia (a condition marked by a tendency to persistent bleeding). It would never occur if routine coagulation times were done on all patients before they entered the operating room. Blood usually clots in seven minutes and if the period of clotting is beyond eight minutes, measures should be instituted to insure the clotting of the blood in a shorter period. There are many conditions which interfere with the normal clotting of the blood, one of the most interesting of these is hemophilia. It is a malady which is transmitted by the female to the male, although rare instances have been reported where women, too, are the sufferers. In this disease, blood often does not clot until 15-20 minutes. Jaundice is another condition which hinders the clotting of the blood. In hemophilia and jaundice and in all cases in which the clotting time is delayed methods must be taken to lower the coagulation time to within normal limits.

Treatment.—Before operation those patients with a prolonged coagulation time should be given calcium lactate, gr. 15, three times a day, in milk, or calcium chloride intravenously, using ten c.c. of a ten per cent. solution in a hundred c.c. of saline daily for three days. If at the end of three days, the coagulation time has not been materially reduced, they should be given from 15 to 30 c.c. of horse serum intravenously. This is very valuable in lowering the coagulation time. Before the administration of horse serum, the patient should be carefully tested by the injection of minute doses of horse serum into the skin to determine whether the individual is sensitive to it. Patients who have recently had those diseases in which horse serum is used as a curative agent, as in diphtheria antitoxin or antimeningococcus serum, have a peculiar idiosyncrasy to it, so that if this serum is given again, a condition of "anaphylaxis" may result.

Anaphylaxis has been defined as "the increased susceptibility to an infection or the action of any foreign substance introduced into the body following a primary infection." This condition is indeed serious, manifesting itself by a sudden, labored respiration, rapid pulse, cyanosis and the appearance of large

red cutaneous blotches, or urticaria. Death has been known to occur within a few minutes. If this condition should result, it is best treated by the administration of atropine hypodermically, or adrenalin, minims 15. The elimination should be further promoted by colon irrigations.

Recent investigations have proved that patients with delayed clotting time are often improved by ante-operative transfusions of human blood. The blood of the patient should be tested first for the particular group into which it falls, and then a transfusion of blood from a donor whose blood group is the same as that of the patient should be given. (This is described in Chapter II.)

CHAPTER IV

THE SURGERY AND SURGICAL NURSING OF THE SKIN AND APPENDAGES

In this and the following Chapters V to XI on surgical conditions involving the systems of the body, the various pre-operative and post-operative nursing measures which are peculiar to the individual case at hand will be indicated, but no standard routine courses of treatment can be reasonably prescribed because every surgeon will have his own. These will necessarily vary from time to time in accordance with differences in patients, operative procedures, general conditions, etc. However, in Chapter XIV, under the subject of "Anesthesia," and in Chapter XVI under "The Operating Room," there are recorded representative practices which, with what is given here, will give the student the framework for surgical nursing.

ACCIDENTAL WOUNDS

Varieties of Accidental Wounds.—A *wound* may be defined as a discontinuity of tissue. It may be superficial or deep, clean or contaminated, accidental or intentional. For purposes of classification, wounds may be divided into abrasions, contusions, punctures and lacerations. When the surface layers of the epithelium are scraped away, the wound is spoken of as an *abrasion*; when they have been destroyed by some pressure, but yet not actually removed, a *contusion* results; a *punctured wound* is the type left by a nail or awl; a *laceration* is caused by the deeper layers of the skin together with the epithelium being torn. All these wounds may be clean or infected. If they are clean they will heal in the manner described in Chapter I. If they are infected by bacteria, the various sequelae which have been already outlined may ensue.

THE TREATMENT OF ACCIDENTAL WOUNDS

In the treatment of any wound, hemorrhage must be arrested first, then an attempt should be made at sterilization, and finally

if necessary and possible, the wound should be sutured and adequately protected from further contamination by an appropriate sterile dressing.

Prophylactic Injection of Tetanus Antitoxin.—In general, all patients with wounds which have been contaminated by soil or manure should be given a prophylactic injection of tetanus antitoxin, and in the case of extensive wounds, in which the muscle has been injured, a prophylactic injection of polyvalent anaerobic serum should also be administered. In order to guard these patients against the dire results of anaphylactic shock (see page 39) it is important to ascertain whether they have had any previous injections of horse serum. If so, they are obviously sensitive to horse serum, and any further injection will result in an anaphylaxis, and possibly in death. If the patient is unconscious, or is a child, one-tenth of a cubic centimeter of the serum may be injected intradermally, and if the reaction occurs within ten minutes, it is safe to assume that the patient is sensitive. If the patient is sensitive to horse serum, he must be desensitized by minute injections given every twenty minutes until this sensibility has been lost. A further discussion of tetanus and gas-bacillus infections will be found on pages 45-46.

HEMORRHAGE

As far as hemorrhage in most superficial small wounds is concerned, it ceases automatically or by pressure applied over the affected surface. This pressure may be made by any sterile substance or, in emergency, freshly laundered materials. However, should the bleeding be of any magnitude, the various measures outlined in Chapter III should be followed. After hemorrhage has been controlled, efforts should be made to sterilize the wound.

WOUND STERILIZATION

In general, the skin surrounding the region of injury should be given a dry shave if necessary, and be cleansed of all foreign material by careful scrubbing with green soap and water, followed by the application of benzine, alcohol and ether. The wound itself should receive the same treatment. It should be thoroughly irrigated with sterile water or saline so as to remove any foreign bodies which may be present, and then depending

upon the size and location an attempt should be made to sterilize the wound either by antiseptic or debridement.

Antiseptics.—An antiseptic substance is a chemical which prevents or arrests the action of bacteria, fermentation, decomposition or disease. The number of antiseptics is legion and only the most important ones will be considered.

Tincture of iodine, usually ten per cent., is excellent, but it has certain disadvantages. There are many individuals who have an iodiosyncrasy to it and react quite readily with signs of iodine poisoning. In addition, it has a tendency to burn the skin, especially in fair-colored individuals. The thoughtless painting and repainting of small abrasions in the tender skin of children or women may result in a burn which is much worse than the original injury.

Peroxide of hydrogen is quite efficacious, especially in wounds in which anaerobic bacteria might be present, in those contaminated by soil and manure. As a matter of fact, in this type of wound, it is a good procedure to first iodinize and then wash thoroughly with peroxide.

Picric acid, mercurochrome and *acriflavine* have enjoyed popularity in some surgical clinics.

Then there are a number of antiseptics which, however, not only kill bacteria but also destroy tissues themselves and occasionally poison the individual. Because of this, solutions of bichloride of mercury and carbolic acid have fallen into disrepute. They possess extremely irritating properties and some danger is always entailed in their use.

Dakin's solution, a solution of sodium hypochlorite, is an antiseptic which liberates chlorine when it comes into contact with the tissues. It is rarely used as a primary antiseptic, but is usually employed to sterilize those wounds which have already become infected, or in which primary sterilization is doubtful. In this type of wound it is used from four to twenty-four hours after injury. The technique of its application is given in Chapter XX.

Debridement.—This procedure aims to cut away all tissue which has been bruised or which has come into contact with any contamination. Theoretically, if this is done carefully and thoroughly, the wound should be sterile enough for primary suture, or if this is impractical, for skin graft (page 53). However, the wound is occasionally packed, and often sutured forty-

eight hours later, or it may be subsequently Dakinized if, after the packing has been removed, there is infection present.

After the bleeding has been stopped and the wound has been cleansed and sterilized, the surgeon usually decides whether the wound should be packed or sutured or simply dressed. This will depend upon the size of the wound, character, its location and the source of injury, and the contamination to which it has been subjected.

WOUND SUTURE

Wounds which gape considerably are narrowed either by adhesive or sutures, because the period of healing and the amount of scar tissue are both lessened. Small wounds may be drawn together by sterile or flamed adhesive, but large wounds require sutures. The materials used for the suture of a wound may be horsehair, silk, silkworm, catgut (either plain or chromic) or metal pincets or Michel clips (see Fig. 104). Horsehair, because it is of fine texture and non-irritating quality, is ideal for face wounds. Wounds in other locations, and deeper in nature, in which tension is present, require material of greater tensile strength. If the deeper parts of the wound must be sutured separately from the skin, catgut is invariably used since it is absorbable.

The needles employed are various sizes of either the full curved or straight Hagedorn type (Fig. 108). Care must always be taken that the eye of the needle is patent, that it will fit the material to be used, that the cutting edge is sharp. Most surgeons hold the needle with a needle holder. The nurse, in placing the needle in the holder, should always appreciate whether the surgeon is right- or left-handed, for this may save a great deal of embarrassment.

Sutures are invariably removed in from seven to twelve days. In neck wounds, where skin clips have been used, these little appliances which approximate the skin edges are removed in four days (Fig. 104).

Dressing of the Wound.—Some wounds such as abrasions, superficial scratches or small incisions, are best dressed with gauze impregnated with some sterile ointment (vaseline, boric acid, liquid albolene). This will prevent the dressing from sticking to the wound, rendering subsequent dressings less painful.

Naturally, if the wound has been sutured or packed, dry sterile dressings are usually applied. The amount of gauze used in any dressings should always be sufficient to adequately cover the involved area, but a bulky dressing is not only uncomfortable and unsightly, but extravagant, and an economic waste of very valuable material. Dressings may be held in place by bandage, adhesive or binders (see page 446). In small wounds the dressing may be maintained by collodion. A coat of this over gauze will attach it quite firmly to the skin.

Clean wounds are rarely redressed before a week but if temperature is present or there are other reasons to suspect infections, the dressing is done much earlier.

COMPLICATIONS OF ACCIDENTAL WOUNDS

Hematomata.—This is usually an accumulation of blood or serum in a recently sutured wound invariably due to poor hemostasis. If the hematoma is small, it may be absorbed. If large, it may be evacuated by incision or aspiration with a syringe. If the hematoma becomes secondarily infected, really forming an abscess, then drainage may be necessary. Other complications are infections of various kinds.

Infections.—(*a*) *Aerobic.*—A wound which has been sutured may become infected by aerobic bacteria and the signs manifest themselves while the patient is under observation or the patient may present himself with an open infected wound. The signs of infection are given in Chapter I.

(*b*) *Anaerobic.* Occasionally due to faulty judgment, a prophylactic injection of tetanus antitoxin or anti-gas bacillus serum is not given wounds which have been contaminated by dirt or feces or which have been inadequately sterilized. As a result, anaerobic infections may develop in the form of a Welch bacillus infection, or possibly tetanus. If either of these two conditions should develop subsequently, every effort should be made to combat the infections as quickly as possible.

Tetanus or lockjaw is a disease caused by an anaerobe, the tetanus bacillus. It occurs mainly in the earth and manure. Its incubation period is from one to twenty days.

The symptoms in the main are those of tonic muscular spasms. There is at first difficulty in opening the mouth, and this is soon followed by paroxysms of generalized tonic muscu-

lar spasms. Death as a rule occurs in three days or sooner in untreated cases.

Treatment.—The original wound should be opened widely, if it is at all suspicious, and treated with peroxide of hydrogen, and the patient should be given huge doses of tetanus antitoxin intravenously and intraspinally to conquer the infection. The patient naturally should be fed by nutrient enemata or nasal gavage if food cannot be given orally. Chloroform may be necessary to control the spasms.

Gas Bacillus Infection.—This horrible complication is due to the bacillus of Welch and other related anaerobic bacilli. The bacillus aerogenes capsulatus is an anaerobe which invades subcutaneous tissues and muscle planes, producing gas. Clinically, there is an elevation of temperature and pulse, the patient appears prostrated, and examination of the wound reveals a copper color of the skin, a characteristic crepitating sound when the wound is pressed and occasionally the escape of small gas bubbles from the wound edges and a peculiar cadaveric odor.

Treatment consists in radical incision and excision of all tissues involved by the gas bacillus and irrigation of the wound with peroxide of hydrogen every two hours. The polyvalent anaerobic serum should be administered every six to eight hours intravenously until the infection appears under control. When the disease is widespread, amputation is the only effective remedy for conquering the infection, but this should always be done well beyond the area of invasion.

THE TREATMENT OF INFECTED WOUNDS

In all infected wounds, the aim of the surgeon is to liberate the pus, establish free drainage, and convert an infected wound into a clean wound. Free drainage may be obtained by radical incision and excision of parts obstructing free drainage, or in the case of recently sutured wounds, by removal of the sutures, which may permit a free escape of pus. Drainage is then usually inserted. Drains are the handiwork of a nurse and their manufacture should be clearly and thoroughly understood. The types of drains (Figs. 105 and 106) and their methods of preparation are described in detail on pages 357-360, but a few comments will be given here on packing, wet dressings and dry heat.

Packing.—If the wound is large and deep, and if it has been contaminated by soil and manure, and the surgeon feels that there is still some danger of anaerobic infection in spite of all he has done, the wound may be packed. Or, if the wound has been incised and a large abscess evacuated, packings may be used. Packings not only act as hemostatic agents, but are quite effective drains. They should be sterile, absorbent, soft and of such material that they will not shed their threads nor flood the wound with foreign bodies. The width and length of packing is dependent upon the area and depth of the wound. It may be used plain or medicated with bismuth, iodoform, balsam of Peru, mercurochrome or other substances. Most packings require changing every two to three days because of the fact that they become saturated with secretions and pus. This is not only productive of disagreeable odors, but it makes a packing act as a plug rather than a drain. If a clean wound is packed, it is perfectly possible to leave the packing in place from ten to twelve days. Some surgeons in packing a large wound will use a Mikulicz tampon or drain. This is really a layer of gauze or rubber dam imbedded into the wound cavity, making a trough into which packings are inserted. This arrangement permits the packing to be changed without disturbing the primary gauze. It is of prime importance that the nurse observe and carefully note at each dressing the number of pieces of packing removed or inserted into a cavity, and whether any have been expelled between dressings.

Wet Dressings.—A wet dressing is useful because moist gauze has greater capillary attraction, and, therefore, favors better drainage. There are several methods commonly applied in keeping dressings wet.

Dressings may be applied wet, or made wet after they have been applied. Rubber tissue over a dressing prevents evaporation of the fluid and acts as a poultice. In the case of the extremities, however, the rubber tissue may be omitted, and the sterile solution poured on the dressings at regular intervals, or the part may be immersed in an arm or leg tub bath at stated intervals. Occasionally when the dressings are applied, catheters or Dakin's tubes may be incorporated in the gauze and the solution introduced through them. Infected wounds which are treated with Dakin's solution require a special technique which is set forth

in Chapter XX. The nurse should take particular care in all wet dressings that the fluid which is applied comes into contact with the wound, and that the surrounding skin does not become macerated or injured in any way. If this tendency is present, a bland ointment applied to the skin will prevent maceration.

Dry Heat.—Some surgeons, instead of using moist applications, prefer the use of dry heat. It should be remembered that in extensive wounds the nerves are often destroyed and sensation is lost, so that all warm applications should be tested first by the hand of the nurse before the heat is applied, for a burn inflicted on any patient is unpardonable. Heat may be applied by hot water bottles, hot poultices, the electric coil or electric pad. These may be applied intermittently or continuously. For the continuous application the best form is the electric coil, as the degree of heat may be regulated and kept fairly constant. Baking a suppurating wound is also occasionally employed and at times found very helpful. Probably there is nothing which gives so much relief as poultices, because they are light in weight and are easily adaptable to the region required. The most common poulticing material is flaxseed, although there are many proprietary compounds which are equally good and less troublesome. Inasmuch as poultices are very apt to lose heat rather rapidly, the electric coil or a hot water bottle should be superimposed. Mustard plasters are rarely used in surgical nursing, because if improperly applied, they burn the skin, and they cannot be used continuously.

TREATMENT OF HEALING WOUNDS FOLLOWING INFECTIONS

When the discharge and induration of an infected wound becomes less, the surgeon will gradually reduce and shorten the amount of drainage present, or if the wound is extensive, in order to hasten sterilization, Dakinization may be employed. The granulations, which at this stage appear pale and unhealthy, may be stimulated either chemically or physically with solutions of silver nitrate, or the actual caustic stick. Balsam of Peru appears valuable on occasions. Careful exposure of the wound to sunlight, the Alpine light or the Chromayer lamp often produces remarkable changes in the appearance of the granulations. When all the drainage has been removed, and the granulation tissue is beefy red in appearance, the size of the wound may be mate-

rially reduced by drawing the adjacent skin edges together with adhesive plaster. At times, strapping of the granulating area with flamed adhesive will not only stimulate the granulations but encourage the growth of epithelium. If the wound is deep and sterile, as bacteriological examination will reveal, secondary suture may be used.

Secondary Suture.—Since it is possible to sterilize infected wounds by the Dakin method, it is perfectly feasible to suture wounds which require it, as soon as three successive smears show no germs. In this way, not only is a great deal of time saved, but the scarring is certainly markedly lessened (see Chap. XX).

BURNS

While a French surgeon originally divided burns into six degrees or stages, according to the depth to which the injury penetrated, it will really suffice for nursing purposes to divide them into three. The agents which produce burns are many. Heat in the form of solids, liquids, or steam; chemicals, such as strong acids—for example, carbolic, acetic, hydrochloric; powerful alkalis such as sodium hydroxide, chloride of lime; special agents, such as X-ray, electrical currents and radium when not properly used, may all cause very severe burns. Closely allied to those burns caused by heat are those due to the action of cold either from exposure to low temperatures, such as frostbite, or those resulting from actual contact with cold substances in the form of ice, snow, or liquid air.

The pathology and clinical appearance of all burns are essentially the same regardless of the agent inflicting the injury, but the degree varies. First degree burns are recognized as those in which there is redness, with some pain and swelling, followed by a scaling of the skin. If the redness is of a greater degree, blisters appear; this is a second degree burn. All other burns might be classified as third degree. They vary from definite charred areas to those cases in which an entire limb or more is involved. The symptoms which result may be classified as local and constitutional.

Local Symptoms.—There is a marked inflammatory reaction of the parts adjacent to the burn followed soon by sloughing of the charred or injured tissues and, finally, after the wound has been cleansed and the granulations are vigorous, healing ensues.

Constitutional Symptoms.—During the first and second periods, there is considerable absorption from the products of destroyed tissue and the patient may suffer from certain constitutional complications; these may be very mild or so severe as to cause death. The causes of death following burns may be shock, poisoning from the charred tissues, or complications arising from infections such as erysipelas or sepsis. It should be remembered that extensive burns rather than limited deep ones are the more serious, and that children with skin burns averaging more than one-third of their body are apt to die from the effects.

It occasionally happens that, in addition to the local burns, the patient may suffer from carbon monoxide gas poisoning.

CARBON MONOXIDE POISONING

This is recognized by the great difficulty with which these patients breathe or the fact that respirations have ceased and the observation that their lips are a very deep red and their skin a bluish cyanotic hue. The condition requires urgent interference.

Treatment.—The blood must be rid of the excess carbon monoxide and its oxygen content increased. The patient must first be removed to the open air and artificial respiration started immediately, preferably by the Schaeffer prone method. The patient, as soon as respirations start, or if breathing has not stopped, should be given a mixture of ninety-five per cent. oxygen and five per cent. carbon dioxide from commercial tanks containing this mixture through an inhalator. If the congestion of the patient is very extreme, blood may be removed from a vein in the arm. This reduces the actual blood content of carbon monoxide, and then the patient may be given an infusion of saline or a transfusion of blood which will still further decrease the amount of poisonous gas.

THE TREATMENT OF BURNS

The treatment of burns may be grouped under two heads,—general and local.

General Treatment.—In extensive burns there is often a deep shock which should be treated immediately. The patient should be placed in the shock position. The body must be kept warm with hot water bottles and blankets. Fluid should be given

either by rectum in the form of a Murphy drip, or in very severe depressed conditions, a saline infusion. If the pain is intense, morphine may be required.

LOCAL TREATMENT OF BURNS

There are no wounds which are treated as poorly as burns. It should always be remembered that burned areas are portals of entry for various pathological bacteria, and excessive care should be taken to guard against infection. The application of unsterile home remedies such as flour and water, olive oil, etc., is to be condemned. If a first aid dressing must be applied, and there are no sterile supplies on hand, it is better to cover the part with a freshly laundered dry towel until proper treatment may be obtained. There are no injuries which are treated so variously by the surgical profession, but each type of treatment claims its enthusiastic followers. Some surgeons use wet dressings of boric acid or saline, others ointments, some fresh air, others dry heat, and still others use the paraffin treatment, which will be discussed later.

There are no cases, however, which require a more standardized treatment, and certainly the recent development of the *tannic acid treatment* should do much to aid in this standardization. For simple first degree burns, in which there is smarting, a paste of bicarbonate of soda or sterile ointment may be applied and the part protected from contamination and air by a dressing, but for second and third degree burns, the following is a good plan of procedure when the tannic acid method of treatment is to be followed:

Tannic Acid Treatment of Burns.—(1) *Emergency treatment:* (*a*) All clothing should be removed without touching the burned areas. (*b*) All gross foreign material should be removed. (*c*) The burned area should be wrapped in sterile sheets or sterile towels, and the patient kept warm with blankets or hot water bottles until removed to a "burn bed." Morphine should be administered liberally if necessary and tetanus antitoxin should be given if deemed advisable.

(2) *Ward or Home Treatment:* Upon arrival at home or in the hospital, the patient is placed in a "burn bed." This is simply an ordinary flat bed in which sterile sheets and towels are placed under the patient and all other dressings removed, for at

no time should either clothing or dressings come into contact with the burned area. The patient wears nothing, and lies, if possible, so that the burned areas are exposed to the air and do not come into contact with the bed. One or more cradles are placed over the burns depending upon their extent, and two electric light bulbs are put inside of the cradles so that a temperature equal to that of body heat may be maintained. The overlying sheets and blankets are then arranged over the cradle. As far as the treatment of the burned areas is concerned, the following have been found quite practical:

1. All foreign material is removed from the burned area. (*a*) The gross dirt is sponged away with peroxide. (*d*) The grease or ointment is removed by ether, or if the ether is too painful, peroxide may be substituted. All loose skin is removed by forceps or by gently wiping it away with gauze. (*d*) If necessary, the hair is shaved even if the burn is severe, although it may be necessary to wait until the morphine has had its effect.

2. The burned areas are then sprayed with an atomizer with a freshly prepared solution of two per cent. tannic acid, every half hour for three hours; then every hour for six hours day and night for thirty-six hours; then every two hours day and night for another thirty-six hours. At least one atomizer full of tannic acid should be used each time. By applying tannic acid, the burned skin is tanned to a mahogany brown, and by this method, the pain is certainly less, and the absorption from the burned area is greatly diminished. The tanned area eventually forms a slough which may be removed, and, if necessary, the underlying area may be skin grafted. After burn wounds have healed, the contracture of the scar tissue may result in the diminution of the normal function of the part, so that massage and active motion should be started early.

Treatment of Burns of the Eye.—(1) *Thermal Burns.*—(*a*) All foreign material should be removed with boric acid solution, and the eyelids should be well anointed with vaseline. (*b*) The eye should be irrigated every three hours with cold boric acid solution followed by two drops of castor oil in each eye, after which ice compresses are applied continuously.

(2) *Alkaline Burns:* The treatment is quite similar except that the eyes are irrigated with a one per cent. freshly prepared tannic acid solution every three hours, followed by two drops of a one

per cent. atropine solution in each eye, followed by two drops of castor oil, after which the eyes are bandaged to exclude the light. Cold compresses are applied if there is any swelling.

(3) *Acid Burns:* Instead of removing all foreign material with boric acid, a five per cent. solution of bicarbonate of soda is used and the eyes are then irrigated every three hours with a cold five per cent. bicarbonate solution, followed each time by two drops of castor oil in each eye every three hours. After this, the eyes are bandaged and cold compresses applied, if necessary.

Paraffin Treatment of Burns.—During the Great War combatant troops were exposed to the terrors of gas attacks and the chlorine and mustard gas left their marks by horrible burns of a superficial and deep nature. The areas were treated by paraffin or a proprietary substance called ambrine. Ambrine is applied by a special apparatus which sprays the warm wax over the wound in a fine layer. The method is somewhat as follows: The part is thoroughly cleansed, dried, and wrapped with a sterile towel. The ambrine is melted by the heat of either an alcohol lamp or Bunsen burner to a temperature of 50° C. In the meantime the water bath for the actual liquefied ambrine is filled with boiling water. The ambrine is poured into the container, the container telescoped into the water bath and the atomizing arrangement is screwed over both. Then by air pressure the liquefied wax is sprayed over the part in a delicate, thin, even film, and the part covered with a fine cotton batting, and a bandage applied. The advantages of this method are painlessness of application, absolute sterility, formation of a soft splint-like dressing over the wounded area, rendering it immobile and thereby diminishing pain. At the end of twenty-four hours due to the exuding serum, the wax layer with the thin cotton batting attached, separates rather easily and painlessly. While this method requires much time and patience, the end results easily compensate for the trouble involved.

Skin Grafts.—In some wounds there may be either primary avulsion of the skin, or the skin may slough away from burns or from secondary infection. After these wounds are granulating and clean, skin grafts may be necessary to promote healing. In other cases, after wounds in which there has been excessive loss of skin have healed, the secondary contracture of the scar tissue may be so great as to limit definitely the actual usefulness

of a part. Excision of this scar tissue, followed by the employment of the proper type of skin grafts, will often work miracles as far as the restoration of function is concerned. Skin grafts are of four varieties: Thiersch, Reverdin, Wolf and pedicle.

Thiersch Grafts.—These are strips of the superficial layers of epithelium cut from the skin with an exceedingly fine, sharp razor. They are placed upon a sterile, granulating area, covered with paraffin gauze, and dressed either dry or wet. The dressing is usually left undisturbed for seven to ten days. If these grafts take successfully, skin is supplied.

Reverdin Grafts.—These are small thin segments of the epidermis which are placed upon a granulating wound. *Pinch grafts* are quite similar except that they are small pieces of the epidermis and dermis. They are treated similarly to the Thiersch grafts.

Wolf Grafts.—In this variety, the entire thickness of the skin is removed as a single piece, and all the subcutaneous fat is removed. The piece of skin is placed over the area to be grafted, and is of such a size as to completely cover the granulating surface. The edges of the graft are sutured to the edges of the skin and good firm pressure is applied to secure good apposition between the free graft and the underlying tissue. The wound is left undisturbed for at least ten days.

Pedicle Grafts.—This is a very useful form of grafting in the secondary type of case, those in which the scar has been surgically removed, and the defect is to be supplied with full thickness skin. It is very effective also in those cases in which the surgeon feels that simple Thiersch grafts will prove inadequate either to prevent secondary scarring or to stand the wear and tear of motion and friction.

The general method of pedicle grafting is the same regardless of the part of body which is to be covered (Fig. 8). The graft of skin is cut a little larger than the amount needed to cover the defect. It is made up of the skin and subcutaneous tissue and it remains connected by its base so that it receives a good and adequate blood supply. The free edges of the skin flap are sutured around the wound edges of the area to be covered. All the parts are then immobilized if necessary with plaster of Paris dressing. After a lapse of sixteen to twenty-one days, the base of pedicle graft can be divided, for by this time, the graft

of skin should have healed so firmly to the granulating area that it no longer needs the blood supply which it receives from the

Fig. 8.—Showing Pedicle Graft taken from the Back and Sutured to the Anterior Aspect of the Neck to Replace a Scar, the Result of a Burn.

pedicle. There are many varieties of pedicle grafts, but these concern the plastic surgeon: In the majority of pedicle grafts, the part will be immobilized in a plaster jacket or spica, and the nurse should not forget any essentials necessary in the application of plaster dressings (see page 170). These patients encased in plaster are often quite uncomfortable because of the positions which they have to assume, and are almost unable to help themselves in the performance of any duty. Every effort should be made to decrease their misery and to make them com-

fortable, and sedatives or even opium should be liberally supplied during their period of plaster incarceration.

INFECTIONS OF THE SKIN AND ITS APPENDAGES

Skin infections are quite common. They may be either generalized or localized.

GENERALIZED INFECTIONS OF THE SKIN

Cellulitis.—This is usually a diffusive infection of the skin and subcutaneous tissues manifested by tenderness, redness, swelling and edema of the skin. Often the area proximal to the infection reveals the red streaks of acutely inflamed lymph vessels draining into the adjacent lymph nodes. These glands often become enlarged and tender. Constitutional symptoms are present in proportion to the severity of the infection and the extent involved. Temperature is usually present and the patient complains of headaches, anorexia and general malaise.

Treatment.—The part is usually covered with wet dressings or soaked in a continuous extremity bath. Multiple incisions are made and drainage established when fluctuation is evident.

Erysipelas.—This is usually a dermatitis and cellulitis caused by a streptococcus. It may either appear as a primary condition or a complication of a wound infection. It is invariably ushered in by a chill and a temperature of 104 or 105. Clinical examination reveals a red inflamed area with sharply demarcated margins slightly elevated above the surrounding skin. The inflammation advances progressively while the first affected parts become paler in color and less edematous. It is a serious complication, especially in the old and the debilitated, and those with alcoholic tendencies.

Treatment.—These patients should be isolated and placed upon individual precautions. The local region is treated with wet dressings of either saline, boric or magnesium sulphate. The general treatment is usually supportive. Some good results have been obtained by the use of a specific serum which has recently been developed.

LOCALIZED SKIN INFECTIONS

Furuncle.—This is a boil invariably developing around a hair follicle. It reveals itself as an area of induration, showing the

signs of acute inflammation, and in the center of this, pus may be present. It should be treated conservatively with wet dressings until it has become localized, and then under ethyl-chloride or local anesthesia, an incision should be made and the wound adequately drained. Further wet dressings are applied until all the inflammation has subsided.

Carbuncle.—This is more extensive than a furuncle and is a phlegmonous inflammation of the skin and subcutaneous tissues. It is often associated with diabetes mellitus. These carbuncles may reach an enormous size and often cause death. As a rule, these infections are incised under general anesthesia. The area of induration is liberally cut by a crucial incision and the four skin flaps are elevated or the entire area is excised. The wound is usually packed and treated by poultices and wet dressings, if necessesary.

Paronychia or a felon is an inflammation of the structures of the distal phalanx of the finger, usually surrounding the nail. After the inflammation has been localized by wet dressings and pus is evident, an incision is made and part of the nail base is cut away, if necessary. Wet dressings are supplied until the condition has subsided.

Fig. 9.—Varicose Veins of the Internal Saphenous Group. (Courtesy of Dr. Edward D. Truesdell.)

Ulcers of the Skin.—These are regularly the result of varicose veins (Fig. 9), occasionally of syphilis and more rarely of carcinoma. The most common place for their occurrence is on the anterior aspect of the lower leg and their sizes vary from a dime to those which practically involve the entire leg. The treatment is always directed to the causes producing the ulcer and to the ulcer itself. The ulcer is dressed either wet or with ointments, and a good firm pressure bandage applied from the toes up to the knee. This will exert pressure on the dilated varicose veins

and improve the circulation, thereby aiding the healing of the ulcer. After the wound is healed, an elastic stocking should be worn, and the varicose veins treated by injection.

The injection of varicose veins aims to obliterate the vein by producing a localized thrombosis. This is accomplished by injecting intravenously into the varicosed vein some irritating substance, either sodium salicylate or a twenty per cent. saline solution.

Some prefer to remove the veins by open operation.

If the cause of the ulcer is syphilitic, then mercurial ointment should be used locally, and salvarsan, iodide and mercury internally. Carcinomatous ulcers will be discussed in the next paragraph.

NEW GROWTHS OF THE SKIN

These are either benign or malignant. The benign tumors of the skin are sebaceous cysts, fibromas and lipomas, the last of which are really fatty tumors arising usually from subcutaneous tissue. These fatty tumors, cysts, and the fibromas, are usually definitely encapsulated and may be excised without any difficulty.

Warts are really a circumscribed hypertrophy of the upper layers of the skin. They may be cauterized with acids or removed with the electric needle.

Malignant tumors of the skin are invariably pigmented moles or ulcers which have undergone carcinomatous degeneration, so-called rodent ulcers. These may be treated by exposure to radium or X-ray (see Chapter XII), or the lesion may be radically excised, and the defect caused by the excision of the skin may be sutured, or, if necessary, healed by skin graft.

THE BREAST

Diseases of the breast form a relatively important chapter in surgery. In the main they are of two great varieties,—those due to inflammation and those due to new growth. Inflammation may involve either the nipples or the breast and may be acute or chronic.

The Nipples.—Cracked or fissured nipples, often seen during lactation, are especially painful because the skin has become broken. They may form a portal of entry for the various micro-organisms and thus give rise to infections of the breast itself, or,

when the child suckles, it may swallow some of the diseased tissues about the cracked nipples.

Treatment.—All nipples after nursing should be thoroughly but gently washed with boric acid, then dried and powdered with borated talcum. If fissures are present the child may nurse through a nipple shield, and in the interval the nipples may be treated with boroglyceride, touched with silver nitrate (solid) or painted gently with tannic acid. These measures suffice, as a rule, to bring the nipple back to its normal healthy status.

ACUTE MASTITIS

Acute inflammation of the breast, known as acute mastitis, usually occurs in women during the close of the lactating period. It is the result of improper hygiene of the nipples, although this may not always be the case.

Symptoms.—The patient may complain of pain and heavy feeling in the breast, and, at the same time, redness, swelling, and areas of hardness may appear in certain parts of the breast. There are a rise in temperature, an increase in the pulse rate, loss of appetite, slight headache, and a feeling of general malaise.

Treatment.—If pus has not yet formed, the breast is elevated with a bandage in such a way that it is firmly supported upward. (See Figs. 162 and 163, page 443.) This will do much to relieve the pain, but care should be taken that the binder is not applied too tightly. Nursing, as a rule, is discontinued, and if the breast throbs and feels distended, the milk may be expressed regularly either by gentle massage, the direction of the massage being a stroking motion from the circumference of the breast towards the nipple; or the milk may be aspirated by a breast pump. During the interval, either hot applications such as flaxseed poultices may be applied to the breast, or cold applications in the form of a magnesium sulphate solution of fifty per cent. strength. When pus is formed the abscess is opened by the attending surgeon and freely drained. After the acute suppurative process has subsided the drainage tubes are shortened gradually and the granulation tissue stimulated by silver nitrate.

CHRONIC MASTITIS

This condition is not uncommon, and presumably is due to a chronic inflammation of the breast. The patient complains of

vague and indefinite pains localized in the breast itself, and, on examination, there may be found here and there some very small nodules which may be tender. At times the lymph glands in the axilla (arm-pit) show enlargement; as a matter of fact this condition is frequently difficult to distinguish from cancer of the breast.

Treatment.—Sometimes a well-fitting breast binder will relieve much of the pain. If there is considerable induration or hardness of the tissue, warm fomentations may bring relief. Should these measures fail, most surgeons will remove that portion of the breast which is pathological. If at the time of operation it is thought that the condition might be cancerous, an immediate pathological examination of the tissue removed is made by means of a frozen section, and if cancer is present the entire breast and deeper tissues are removed.

BENIGN GROWTHS OF THE BREAST

As in other locations those tumors which invade breast tissue may be either benign or malignant. Of benign tumors of the breast, the most common are fibroadenomata; these occur mainly in young women; they are definitely encapsulated, freely movable, do not grow beyond a certain size, and cause no enlargement of the lymph glands of the axilla.

Treatment.—The treatment is the excision of the growth, with occasional drainage of the space left by its removal for twenty-four hours.

CARCINOMA OF THE BREAST

Carcinoma of the female mammary gland is relatively common. (Fig. 10.) The rate of growth of the tumor cells will vary greatly. Any mass in the breast is strongly suspicious of carcinoma if it occurs after the age of forty, and is hard, not definitely encapsulated, and attached to the skin or deeper muscular layers. The glands in the axilla may be enlarged at a very early period. If the disease has lasted for some time the patient may be emaciated, pale, anemic and weak.

Treatment.—The treatment is radical excision of the entire breast and the lymph glands which drain it. Inasmuch as some surgeons perform a rather wide excision, the skin of the patient should be prepared from beneath the angle of the jaw to the

umbilicus, from well beyond the midline of the affected side to the region beyond the axillary border of the scapula (shoulder blade). This preparation, in the main, will consist of shaving the hair. Some surgeons prefer no pre-operative preparation of the skin other than that of cleansing it with green soap and water, leaving the iodine to be painted on in the operating room;

Fig. 10.—Carcinoma of the Female Mammary Gland.
(Courtesy of Dr. Wm. Bayard Long.)

others will have the skin cleansed with green soap and water, followed by alcohol, then ether, finally applying sterile dressings.

Operation.—The anesthesia may be given either by the Bennet method or intranasally. A sandbag is placed beneath the shoulder blade of the affected side. (See Fig. 92, page 339.) The arm may be put out either at right angles to the body, straight, or at right angles and bent at the elbow to an angle of forty-five degrees. Inasmuch as many blood vessels are to be

cut, there should be an abundance of hemostatic clamps and catgut ligatures. The surgeon will employ a drain, either the tube or cigarette variety. After the operation, an abundance of dressing is applied, for there is apt to be a great amount of oozing. The arm, forearm, and hand, as a rule, are bound tightly to the chest.

Post-operative Treatment.—As soon as the patient recovers consciousness she is given a backrest, so as to sit almost upright in bed. As a rule, a dressing is done at the end of twenty-four to forty-eight hours, and the drainage tube removed. At this dressing the arm is left free out of the bandage, and is held in a sling at right angles. The arm should be given passive movements carefully and gently, every two hours. The purpose of this is to diminish the adhesions during healing so that the scar will not limit the motion of the arm.

Patients are allowed up at the end of a week, and in about six weeks after operation X-ray treatment is begun. (See Chapter XII.) This is used to kill some of the cancer cells which may have escaped the instrument of the operator. Some surgeons at the time of operation will expose the wound to radium for a certain period of time, doing the suturing later. Occasionally the arm may be swollen a few weeks after operation, but this may be lessened by massage and bandaging, although sometimes in spite of this, the arm remains large, interfering greatly with its movement.

CHAPTER V

THE SURGERY AND SURGICAL NURSING OF THE ALIMENTARY SYSTEM

Before considering the surgery of the alimentary system, a brief review of those organs which constitute it may be instructive.

I. Organs of the Alimentary Canal:

1. Mouth
2. Pharynx
   (1) Tonsils
   (2) Adenoids
3. Esophagus
4. Stomach
5. Small Intestine
   (1) Duodenum
   (2) Jejunum
   (3) Ileum
6. Large Intestine
   (1) Cecum and Appendix
   (2) Colon
      a. ascending
      b. transverse
      c. descending
   (3) Sigmoid Flexure
   (4) Rectum
   (5) Anus

II. Accessory Organs of Digestion:

1. Teeth
2. Tongue
3. Salivary Glands
   (1) Parotid
   (2) Submaxillary
   (3) Sublingual
4. Pancreas
5. Liver and Gall Bladder

THE MOUTH

The mouth is of special interest because it comprises part of the operative field of the upper and lower jaws, and the tongue; it is the gate through which the tonsils and the adenoids are approached and the means by which the trachea and esophagus are entered. Its main importance from a surgical standpoint is that it can never be rendered sterile, so that all the operations on the aforementioned organs must of necessity be contaminated. Even though the work is done in a contaminated field, the same aseptic surgery should be practised here as is practised in other regions.

This fact should not deter the nurse from getting the mouth as clean as possible for the operation. It is usual to have the patient wash the buccal cavity every two hours with some liquid, either warm saline, or water to which has been added one of the countless pleasant-tasting antiseptics which are in everyday use. This should be begun about two days prior to the operation. It is imperative that mouth washing should be done thoroughly. The nurse should not content herself by simply informing the patient that the mouth is to be washed, but she should stand by and see that it is efficiently done. In addition, the teeth should be carefully brushed at least after each meal. If pyorrhea exists, the teeth should be scraped and the gums treated by a dentist. In this way the amount of mouth contamination may be reduced to the minimum.

The *inflammatory affections* of the jaws, such as inflammation of the gums, or gingivitis, or pyorrhea alveolaris, need no special mention here.

Infections of the Floor of the Mouth.—Occasionally there is a phlegmonous infiltration of the tissues of the floor of the mouth and the submaxillary region of the neck. It is very serious because not only is the toxemia extreme but the proximity of the inflammation to the larynx may cause dyspnea, asphyxia and death.

The treatment is usually incision and drainage through the neck, often accompanied by removal of the submaxillary salivary gland to get better drainage.

Salivary Calculi.—These are small stones which develop in the submaxillary salivary gland or in its duct (Wharton's). The treatment is removal of the calculi usually through the mouth,

but if the gland is involved by infection, it may be necessary to remove it.

Parotitis.—This is an inflammation of the parotid gland which may occur after operations performed on debilitated patients. It is invariably caused by an infection traveling up the parotid duct (Stenson's duct), due to the fact that the mouth and teeth have not been kept clean. It manifests itself by swelling of the parotid, pain and difficulty in opening the mouth. It is a serious complication not only because it is extremely painful, but the toxemia is an added insult, often turning the tide against the patient.

Treatment.—At first conservative measures should be tried, either the application of ice or heat to the enlarged gland. Some surgeons employ gentle massage, endeavoring to express the retained secretions through the duct. Meanwhile, the mouth is irrigated every two hours with hot antiseptic solutions. If suppuration occurs, the gland is adequately incised and poultices are applied until the inflammation and swelling have disappeared.

THE JAWS

The jaw may be the seat of a variety of tumor formations:—(1) Cysts arising from some abnormality in the development of the teeth; (2) non-malignant growths, or epulis; and (3) malignant growths.

Treatment of New Growths of the Jaws.—If the cysts are small, they are removed and the membrane which lines the cavity is destroyed. If necessary, the cavity is packed and the wound permitted to heal by granulation tissue. The only treatment is to keep the mouth clean.

In the case of benign tumors, the tooth about which the tumor grows is removed and with it a portion of the bone. The removal is accomplished by a Gigli saw. (See Fig. 115 D.) It is always convenient to have at hand an actual cautery or Horsley's wax to control the hemorrhage which may ensue from the bone.

The cases of malignant growths, either carcinomas or sarcomas, demand radical operation. In the case of the upper jaw this is not very practical because, with removal of the bone, the eyeball loses its support and drops from its normal anatomical position, resulting in a condition of double vision or diplopia;

and, by removing the hard palate, a communication is made between the nose and mouth. However, in spite of these two obstacles, the operation is occasionally done.

The removal of the lower jaw, however, is not so difficult; it may be removed either partially or in its entirety. The actual operative technic is more of interest to the surgeon than the nurse and will not be discussed here. The nursing procedures are the same as for any radical operation on either the upper or lower jaw.

Ante-operative Treatment.—As has been mentioned previously, the mouth should be cleansed very carefully. The operative field, in the male, should be prepared by shaving an hour before the operation, as the beard sometimes grows very rapidly and nothing is more disagreeable than to have the patient enter the operating room not properly prepared.

Operation.—The anesthesia is given by intratracheal insufflation, a method whereby the vaporized ether is forced into the trachea through a catheter by means of a special apparatus. With this method the anesthetist is removed far from the operative field and the surgeon is able to work undisturbed. The head is draped as is shown in Fig. 99 (page 344). The instruments for this operation are those used for any bone work. (See Figs. 114-115.)

Post-operative Treatment.—The packing, which is introduced at operation into the area vacated by the maxilla, is removed, as a rule, after twenty-four hours. The space left by the removal of the upper jaw should be sprayed through the mouth every two to three hours with some antiseptic solution. The patient, as soon as he is able, should wash his mouth himself every two or three hours. For the first three days, it is better not to give food by mouth; the nourishment is supplied either by nutrient enemata, or by nasal gavage, the catheter being passed through the nostril on the sound side. As soon as the wound granulates, the patient may be given a liquid diet, the food always being introduced along the sound side of the mouth. Great care should be taken that the mouth be thoroughly cleansed after each feeding. Some surgeons request that the cavities be lightly packed with gauze during feedings so as to prevent the liquid food from entering the operative wound. This is not so important a procedure with liquids as it is with soft

diet, which is allowed after about three weeks. It is unnecessary to confine the patient to bed any longer than four days, provided that everything goes smoothly, for needless confinement to bed often causes weakness.

THE TONGUE

Those conditions which demand radical operative procedure on the tongue are invariably due to malignant disease, and may require that the tongue be removed in part or half or completely extirpated. Removal of the tongue (glossectomy) is accompanied by a preliminary removal of the glands of the submaxillary triangle and a ligation of the lingual artery which supplies the tongue with blood. By ligating this artery before a removal of the tongue is attempted, hemorrhage is very markedly diminished at the time of the radical operation.

Ante-operative Preparation.—This consists of the usual cleansing of the mouth as already outlined in the discussion of operations upon the jaw.

Operation.—The anesthetic is administered intranasally. The mouth is kept open by a self-retaining gag. A heavy silk ligature should always be at hand for introduction through the base of the tongue. This serves as a tractor, and even after the tongue has been removed the ligature is left in place, the free end being fastened either to the teeth, or identified by an attached pair of forceps that hang from the mouth. This ligature should remain in place for at least twenty-four hours after operation, for it is invaluable in controlling the base of the tongue should any serious hemorrhage occur.

Post-operative Treatment.—In those conditions in which either half or the entire tongue has been removed, the treatment of the raw denuded surface of the floor of the mouth is what most concerns us. The desideratum, of course, is to render this area aseptic. To attain this end, some operators use balsam of Peru, which is applied as gently as possible. The dusting of iodoform powder is to be condemned, as iodine poisoning may result. Other surgeons prefer the use of mild antiseptic sprays.

For about four days, the patient should be fed by enemata. Each morning the bowels should be washed out with a soapsuds enema followed by rectal feedings (Chapter XIII) which are given, as a rule, every four hours. If the patient is very

weak and emaciated, and demands more nourishment than can be given by rectum, a small stomach tube may be passed through the nostril into the stomach, and left in place. Some operators prefer that the patient be fed directly by mouth; a soft rubber catheter is passed along the normal side of the mouth, permitting the patient to swallow the liquids which are poured slowly through the tube. Each feeding should be completed by the administration of sterile water, and the tube withdrawn, after which the mouth should be thoroughly cleansed. Soft diet may be given as soon as the wound heals and swallowing without difficulty is possible. The patient should be permitted to sit up in bed as soon as possible, and so as to afford better drainage to the secretions which collect in the mouth, the head should be kept bent slightly forward. These cases may be allowed up from bed about the fourth day.

Treatment of Inoperable Cases.—While all patients suffering from inoperable cancer are miserable, there are none who present such a horrible spectacle as those with a large fungating growth of the tongue. Unable to swallow, finding difficulty in breathing, suffering agonies, with an oral stench which is hardly bearable to themselves or others associated with them, they are entitled to all the sympathy possible. If nothing else can be done for these unfortunates they may be kept absolutely free from pain. The local pain is sometimes reduced by dusting the ulcerated areas with orthoform powder. It is applied before any food is taken. Morphine should be given liberally, with a little atropine to prevent its depressing effects. The foulness of the breath may be lessened by the continual use of mouth washes and mouth irrigations. If dyspnea becomes marked because of crowding of the larynx by growth, tracheotomy may be necessary. If difficulty exists in swallowing, rectal feeding may be given. Feeding by stomach tube or nasal gavage is not practical, because the rubber tubes coming in contact with the growths cause excruciating pain. Occasionally, the proper use of radium and X-ray, in selected cases, in which the knife of surgery has failed, will do much to give relief.

THE PHARYNX

The pharynx is important surgically because it lodges the tonsils and the posterior portion harbors the adenoids. As is

known, the tonsils may be the seat of acute inflammation, and the bacteria may spread into the surrounding tissues, giving rise to what is popularly known as a quinsy sore throat, or a peritonsillar abscess.

Treatment of a Peritonsillar Abscess.—Since this condition is in reality an abscess formation, means should be taken to cause a pointing of the abscess as soon as possible. With this ultimate end in view, flaxseed poultices should be applied every two hours to the side of the neck that is affected and warm throat irrigations with a quart of saline at 105° should be given at regular intervals. This will not only cause a localization of the pus, but will be very comforting to the patient and relieve much of the pain which accompanies this condition. The abscess is opened by blunt incision under local anesthesia and pus evacuated. Severe shock and even death have been known to follow this simple procedure, so that cardiac stimulants should always be kept near at hand for this untoward emergency. The after treatment is simple, consisting mainly of throat irrigations and antiseptic mouth washes to relieve the oral fetor and promote drainage.

THE TONSILS

Tonsils are removed very often, both because of a diseased condition and because of an increase in size, or hypertrophy. As a rule the operation is attended with very little risk and is performed under ether in children, and with local anesthesia in adults.

Operative Treatment.—The patient, if a child, is placed under ether anesthesia in the dorsal position and the mouth held open by a self-retaining gag. An electric head lamp worn by the surgeon supplies the light. The tonsils are removed by one of several methods, either by blunt dissection with a Sluder tonsillotome, or they are dissected out with scissors, and finally enucleated with a snare. (See page 374, Fig. 112.) The hemorrhage is controlled by the simple pressure of gauze sponges. The excess blood and mucus may be removed by suction. If necessary, the bleeding vessels may be tied, or a sponge with a piece of tape securely attached may be left in the tonsillar fossa for twenty-four hours. After the operation has been completed, to further stop bleeding and cause the patient to regain conscious-

ness as quickly as possible, the neck and face are bathed with towels previously soaked in ice water.

After Treatment.—Since these cases are apt to ooze a little after operation, careful watch should be kept on their pulses; and if they are bleeding briskly, as evidenced by the constant expectoration of bright red blood, or the vomiting of large quantities of altered blood, the attending surgeon should be notified immediately, for cases of fatal hemorrhage have been known to result.

The diet should be liquid, ice cream being given to children, for the cold is gratifying to the throat, and the psychic effect cheering to their depressed spirits, and, in addition, the cream forms a protective layer to the denuded areas of the pharynx. The patient is kept indoors for a day or two to prevent catching cold.

ADENOIDS

Adenoids are removed either with a curette or an adenotome. (See Fig. 112.) This operation requires no special treatment beyond that already mentioned for tonsillectomy.

THE ESOPHAGUS

While the esophagus is as important as any other structure of the body, its surgery is in its infancy and the operations few in number. Those diseases which interest the surgeon have very little need for a nurse, since whatever is done in the way of treatment is non-operative and performed by the surgeon himself.

Diseases of the Esophagus.—The esophagus may be burned by the passage through it of foreign substances, or injured by the passage of foreign bodies. This will result in an ulceration of the esophagus, with a resultant contracture and stricture, making swallowing rather difficult. Of course, as in other locations, cancer may elect the esophagus, but since it involves this organ at its lowermost portion just where it pierces the diaphragm muscle, very little is done for it by active surgical intervention.

Treatment.—If the esophagus has just been burned by acid, then alkali must be given in the form of a solution of sodium bicarbonate. If caustic alkali is the agent which has been ingested, then a diluted vinegar solution is given to neutralize

the base. The stricture resulting from the healing of the injured area of esophagus is treated by the passing of esophageal sounds, or bougies. These are passed at frequent intervals, the diameter of the bougie being increased in size until the esophagus has been dilated to normal. If the ulceration is very widespread, the dilatation of the esophagus is impractical, and because of its extensive nature, more radical procedures must be adopted.

The patient, being unable to swallow, cannot be nourished indefinitely by rectal enemata, so that an opening must be made directly into the stomach. Through this fistula the food may be introduced and the patient receive the proper nourishment for his existence. This operation is known as gastrostomy, which is described in detail on page 72.

Foreign Bodies in the Esophagus.—The esophagus, as well as the trachea and larynx, is often the resting place for swallowed foreign bodies, such as coins, pins, etc. It is very important to really ascertain that the patient has a foreign body, and the X-ray is a valuable aid in determining the presence of many varieties. Some of these may be removed by special instruments—for example, a coin-catcher—or by direct vision through an esophagoscope. If these bodies are of too great a size to be easily dislodged and are caught fast in the cervical region of the esophagus, the esophagus may be opened through the neck, and the object extracted. The operation is spoken of as esophagotomy. If the foreign body is close to the cardiac portion of the esophagus it may be removed indirectly via the stomach by a gastrostomy.

Esophageal Diverticula.—These small out-pocketings of the esophagus have caused patients trouble because food is retained in them and secondary infection may occur, causing great difficulty in swallowing. These diverticula as a rule are removed in two stages. In the first stage the diverticulum is mobilized and surrounded with packing, and in the second stage it is removed. After it has been removed, the patient is usually fed either by rectum or nasal gavage through a duodenal tube.

New Growths of the Esophagus.—While a resection of the esophagus is sometimes performed for malignant stricture, the mortality is so high and the results so uncertain that conservative rather than radical measures are invariably employed. Most

surgeons are content to introduce radium through an esophagoscope into the esophagus and permit the metal to exert its rays upon the tumor cells and thus hinder their extravagant multiplication. Occasionally surgeons perform a gastrostomy, so that the patient will not starve to death.

GASTROSTOMY

When the esophagus is narrowed by either a benign stricture or carcinomatous tissue to such an extent that feeding is practically impossible, a gastrostomy must be performed to prevent the patient from starving. This is an operation whereby a communication is established between the anterior surface of the stomach and the anterior abdominal wall. Through this gastric fistula, fluid may be introduced, the patient, in this fashion, being given nourishment without the food actually entering the esophagus. There are different types of operations done but they all are essentially the same: they vary in their technic.

Ante-operative Treatment.—The abdomen is prepared in the usual manner. Inasmuch as these patients are very emaciated and weak, the operation is performed under local anesthesia, preliminary to which morphine gr. ¼ with atropine gr. 1/150 is given hypodermatically.

Operation.—The abdomen is opened by a left rectus incision, the stomach found, and packed off from the rest of the abdominal cavity with hot saline pads. A small opening is made into the stomach and a sterilized catheter is introduced into its interior. The further burying of the catheter within the stomach, so as to prevent regurgitation of stomach contents through the fistula, is a matter of technical detail. The peritoneum is then narrowed and a few sutures are taken approximating it to the stomach, so that this organ is held firmly to the abdominal wall. The catheter is brought out of the skin incision and clamped.

After Treatment.—The patient is fed every four hours through the catheter. A convenient way of doing this is to connect it with a small funnel so that the fluids may be easily poured into the stomach. The foods which may be given are limited to those which can be made up into or dissolved in fluids, and from six to ten ounces of liquids may be given at a feeding. Their caloric value should always be estimated and great care should be taken to see that the patient is given suffi-

cient food. Some surgeons permit their patients to chew solid food for the taste and because a flow of gastric juice is stimulated by the hormone secretin of the saliva; but, naturally, the patients are not permitted to swallow the food.

After the first few days the catheter should be removed and changed daily, a fresh clean one always being ready for immediate insertion. After the feeding, the end of the tube should be clamped so as to prevent leakage, and an abdominal binder applied. In about two months' time the tube may be left out of the stomach, and inserted at the feeding periods only. The fistula in the interim may be covered with a piece of vaselinated gauze, held in place by a binder. Patients should be taught to insert their own tubes, the method of feeding themselves, and the foods which may be taken.

It is highly important that the skin about a gastric fistula be kept scrupulously clean. Should gastric contents leak either from or around the tube, the skin should be washed immediately and covered with some bland non-irritating ointment, such as Beck's paste or vaseline. If this is not done, the gastric juice will digest the skin and a painful ulcerated area about the tube may result.

THE STOMACH

The surgery of the stomach forms one of the most brilliant and important chapters in general abdominal surgery, for each year brings new gastric operations with a more refined technic.

Operations upon the stomach, or, in fact, any part of the intestinal tract, introduce an element which is of great importance from the standpoint of an operating nurse. The operative field in a simple celiotomy (the opening of a peritoneal cavity) is clean, and under normal conditions, free from all bacteria. Yet the interior of the small intestinal tract and colon, and, to a slighter degree, the stomach, are swarming with bacteria. Naturally, in those operations which necessitate an opening into the stomach, intestines, or colon, a previously clean field will be converted into a "dirty" one. However, by carefully padding off the operative field from the rest of the peritoneal cavity, and by later carefully discarding those instruments (needles, ligatures, sponges, towels, etc.) which have come into contact with the contaminated field, it is perfectly possible to maintain the

sterile toilet of the peritoneal cavity. This will be discussed in greater detail subsequently. And it is upon the nurses in the operating room that this routine and its observances are partially dependent.

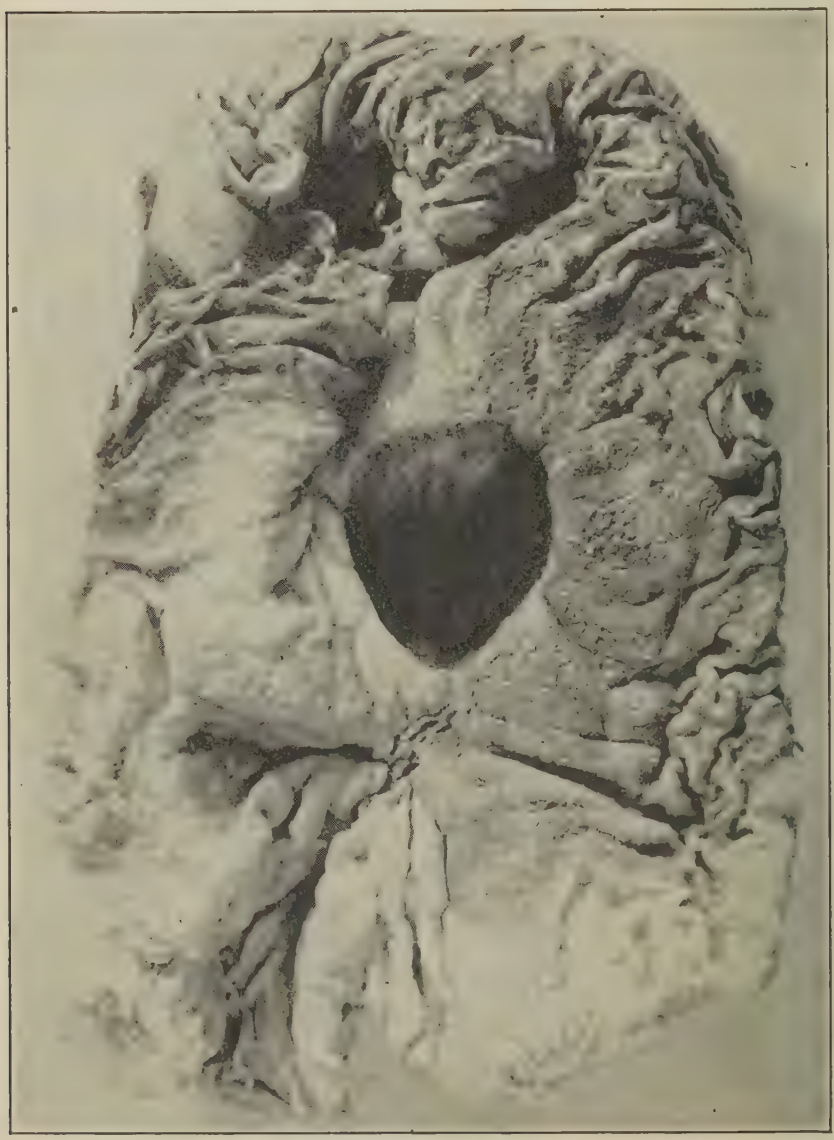


FIG. 11.—LARGE PENETRATING ULCER OF THE STOMACH FOR WHICH A SUBTOTAL GASTRECTOMY WAS PERFORMED. (Courtesy of Dr. Lewis F. Frissell.)

DISEASES OF THE STOMACH

The stomach may be subject to various inflammations of the mucosa from a variety of causes. These are considered under the general heading of gastritis. They are of little interest

FIG. 12.—BARIUM X-RAY OF AN HOUR GLASS CONTRACTURE OF THE STOMACH SHOWING A PENETRATING ULCER. (Courtesy of Dr. Richard Lewisohn.)

surgically. The affections of the stomach which demand surgical treatment are those of gastric ulcer and gastric carcinoma.

Gastric Ulcer.—Gastric ulcer (Fig. 11) starts as an erosion of the mucosa of the stomach, the ulceration gradually extending deeper, at times eating its way through the muscular and serous coats of the stomach, causing a communication between the

interior of the stomach and the general peritoneal cavity. The ulcer in itself is not very serious, but by growing may open a blood vessel, causing a gastric hemorrhage (hematemesis). Or the scar tissue which follows in the path of a healing ulcer may interfere with the gastric functions by creating various deformities of the stomach, such as an "hour glass" stomach. (Fig. 12.) This is especially true when the ulcer occurs in the region of the pylorus; subsequent healing of an ulcer in this location may result in a narrowing or stenosis of the pyloric orifice. The third danger already mentioned is that of perforation, through which the gastric contents are emptied into the general peritoneal cavity, resulting in a peritonitis.

Symptoms.—The symptoms of gastric ulcer are briefly epigastric pain which usually occurs soon after eating, made worse by food and usually alleviated by soda bicarbonate. This pain is often accompanied by vomiting and the vomitus may contain microscopic or macroscopic blood. The belching of sour acid material is usually a constant symptom. Examination of the stomach contents by means of an Ewald or Rehfus test meal reveals an increase in the amount of free and total acid of the stomach (hyperacidity), and the presence of blood. X-ray examination with barium meal may reveal an irregularity in the outline of the stomach, a "niche" indicative of ulcer. (Fig. 13.)

Treatment of Gastric Ulcer.—The treatment is both medical and surgical. The latter only will be discussed here. Surgical treatment is employed when (1) medical treatment has given little relief, (2) when perforation of the ulcer has occurred, (3) when perforation has resulted in the formation of an abscess, (4) when the pylorus has become stenosed, (5) for uncontrollable gastric bleeding.

The surgical treatment of chronic cases resolves itself under two headings: (1) conservative and (2) radical surgery.

Conservative Surgery may simply short-circuit the food contents from the stomach to the jejunum directly, instead of first passing through the pylorus and duodenum. This will permit the ulcer to heal by giving the pyloric portion of the stomach a functional rest; and, in those cases of pyloric constriction, the food will now have a free exit through the new opening. The establishment of a new opening in the stomach and attachment to it of the intestine is known as gastroenterostomy. The jeju-

num may be attached to either the anterior or posterior surface of the stomach, resulting in either an anterior or posterior gastrojejunostomy.

In some instances the operation of gastroenterostomy is accompanied with the local excision of the ulcer.

FIG. 13.—BARIUM X-RAY OF A PENETRATING ULCER. (Courtesy of Dr. Richard Lewisohn.)

Radical surgery contents itself with the removal not only of the ulcer but of the ulcer- and acid-bearing area of the stomach. In other words, in this operation a partial resection of the stomach is performed, removing the pylorus, the antrum, and occasionally part of the cardia. The portion of the stomach

which remains is either anastomosed to the duodenum (Billroth I type of operation) or if this is not possible, to the first portion of the jejunum (Billroth II type of operation). The technical details and names of the various modifications of these two methods are relatively unimportant and unessential for the nurse.

GASTROENTEROSTOMY AND PARTIAL GASTRECTOMY

Ante-operative Treatment.—In chronic cases of ulcer of the stomach prior to the time of operation, fluid should be forced upon the patient so that there will be a reserve amount in the tissues. An hour before operation the stomach is washed. Great care should be taken that the return flow is absolutely clear at the completion of the treatment and that none of the lavaging fluid is left within the viscus.

Operative Treatment.—The operation of gastroenterostomy will be briefly outlined, demonstrating the manner in which the sterility of the peritoneal cavity can be maintained although the stomach and jejunum have been opened and the field contaminated. After the skin incision has been made, some surgeons clamp sheets to the subcutaneous tissues. The incision is then deepened through the fascia and muscles, the peritoneum opened, and the stomach and the jejunum delivered into the wound. The jejunum is stripped free of its content, and an intestinal clamp with rubber-covered blades applied lengthwise (see Fig. 110). The stomach is clamped in a similar manner. The immediate operative field is padded off with hot gauze pads and the surrounding sheets are further protected with additional towels. The stomach and jejunum are then brought into proximity by an approximating Cushing suture, using Pagenstecher linen thread on a straight round needle. This suture should be sufficiently long to completely encircle the stoma between the stomach and intestines. The needle and thread are protected with gauze for the time being. The stomach and intestine are now ready to be opened. From now on until a sterile field is reëstablished everything contaminated from contact with the open gut should be placed on a tray provided for dirty instruments. The surgeon and his assistants must not touch anything on the clean instrument table, and the sterile nurse must avoid touching with her gloved hands, anything that

has come into contact with the contaminated operative field. After the redundant mucous membrane has been trimmed, the mucous coat of the stomach is ready to be united to the contiguous mucous coat of the jejunum. This is accomplished with through-and-through lock stitch using number 0 or 1 chromic catgut on a round straight needle for one-half the circumference of the opening, a through-and-through Cushing stitch completing the closure. *The contaminated field is now sealed off;* clamps, soiled gauze pads, instruments and towels are removed and the gloves of the surgeon and his assistants are either washed in bichloride or exchanged for a new pair. The suture line is cleansed with saline solution and fresh pads reapplied. The suture is reënforced with Cushing suture of Pagenstecher linen thread, as a continuation of the original approximative linen suture. After the opening of the transverse mesocolon has been sutured around the union between the stomach and the jejunum with interrupted number 1 plain catgut on a round curved needle, the gut is washed with saline solution and fresh towels placed about the operative field. The hands are again washed with bichloride, the gut returned into the peritoneal cavity and the abdomen closed.

This will give an idea of the great care which must be taken throughout the operation to maintain strict asepsis, and the nurse must be ever on the alert to see that the technic is rigidly followed.

Occasionally in order to save time, an anastomosis between the stomach and the jejunum may be made by means of a *Murphy button* (Fig. 14 D, and D, E, F, Fig. 110) instead of suture. This is a metal appliance consisting of two hollow cylinders, one-half of which is introduced and sutured into the stomach and the other half into the intestine. The two are then joined and locked automatically, establishing the anastomosis and retaining the stomach and jejunum in position by the serous surfaces. After the gastroenterostomy has healed, the button works its way free and is passed in the stool. The average time for a button to pass is from 10 to 14 days and all stools must be carefully examined for its presence.

After Treatment.—When the patient has recovered from the anesthesia, he is placed in Fowler's position. This posture favors the passage of ingested food through the new opening,

the gastroenterostomy stoma. Although some surgeons permit the oral administration of fluid as soon as nausea and vomiting have ceased, it is better practice to allow nothing by mouth for at least 16 to 24 hours. During this period, fluid may be supplied by hypodermoclysis, given twice a day or every six hours. In addition, retention enemata consisting of glucose 10 per cent. oz. 3 and soda bicarbonate 5 per cent. oz. 3 are administered every six hours. Some surgeons prefer the Murphy drip to retention enemata, which should be kept flowing for about four hours and interrupted for two. As a rule this simple expedient will insure the proper absorption of the fluid and will prevent the irritability of the rectal mucosa. During this period, the mouth is washed frequently and the lips and tongue are moistened with lemon and albolene. This may prevent cases of parotitis (see page 65).

Within 16 to 24 hours all subcutaneous and rectal fluids are stopped and water is given by mouth, usually in one or two dram doses every half hour. If this is well tolerated after a few hours, an ounce of peptonized milk is allowed every two hours alternating with water every two hours. This may be followed on about the second or third day by an ordinary Lenhartz diet. In some hospitals, a special gastric diet has been arranged for these patients. Outlines of these will be found in Chapter XIII.

COMPLICATIONS AFTER GASTRIC OPERATIONS

Hemorrhage.—Occasionally, after the operation, the pulse may mount in frequency and the patient exhibit all the clinical symptoms of hemorrhage. This is evidence of gastric bleeding. The patient should immediately be placed in an upright position in bed, and cold applied over the upper epigastrium by ice bags, ice coils or cold compresses. Cold may be applied internally by permitting the patient to swallow small pieces of cracked ice. Adrenalin hydrochloride 1-1000 may be given in saline solution by mouth to control the bleeding, for its local action as a vasoconstrictor is well known, and at times it is a very efficient hemostatic. If it persists a lavage should be done.

Vomiting.—In spite of the fact that an operation has been performed upon the stomach itself, the surgeon will order a

gastric lavage eighteen to twenty-four hours after operation if the vomiting is persistent; this may be repeated as often as is necessary. The lavage is usually done with ice water especially if there is hemorrhage, and only small quantities are used at a time.

Gastric and Duodenal Fistula.—One of the most dreaded complications following a partial gastrectomy is that of fistula formation from either the sutured stomach or duodenum. It is evidenced by a profuse discharge from the wound of either gastric or duodenal contents which soon erode and digest the skin. Inasmuch as any nourishment given by mouth is discharged almost immediately through the fistula, death occurs quite rapidly from inanition unless heroic nursing and surgical measures are taken. All fluids should be stopped by mouth, continuous intravenous glucose or saline should be given immediately, and, if necessary, blood transfusion. The discharge from the fistula should be kept from washing the skin by continuous aspiration obtained either through electric suction drainage or syringe aspiration (see Fig. 66). The skin must be protected adequately by Beck's paste, lanolin, zinc oxide and talcum or paraffin. If the patient appears to be losing ground rapidly, a *jejunostomy* should be performed for feeding purposes. A jejunostomy is an opening in the jejunum quite similar in principle to a gastrostomy. Not only can fluid and nourishment be introduced through it but the gastric and duodenal contents which has been aspirated from the fistula tract may be reintroduced and thus the patient conserve the body secretions. As soon as the fistula has healed, the jejunostomy tube may be removed and the patient fed cautiously by mouth. The jejunostomy usually closes spontaneously, but if it does not, the intestinal fistula may be closed by operative interference.

PERFORATED GASTRIC ULCER

Ante-operative Treatment.—Patients suffering from a perforation of a gastric ulcer have, as a rule, a beginning peritonitis, and as they are more or less in a condition of shock, it is advisable that before operation ¼ grain of morphine be given hypodermically. This will relieve to a degree some of the intense cramp-like pains and will make the inductive stage of anesthesia

smoother so that the struggling is less. If they are in a state of severe shock, a preliminary infusion of about 550 c.c. of saline should be given.

Operation.—The abdomen is opened, the region about the stomach carefully padded off with moist hot pads and the perforation hunted for. When found, if practical, it is enclosed and inverted with a purse string suture. A thorough lavage of that region of the peritoneal cavity is performed by washing out the upper abdomen with warm saline, sponging out the saline or using an aspirator attached to a suction machine. Some operators are accustomed to leave 500 c.c. of saline in the abdomen before closing. The question of drainage is left to the discretion of the individual surgeon.

Post-operative Treatment.—As soon as possible the patient is placed in the Fowler position, and if greatly shocked a clysis is given, of 500 to 750 c.c. of saline. Some prefer the administration of saline by rectum, given by Murphy drip, four hours on and two hours off. Feeding is begun after eight to twenty-four hours, and the patient may be placed upon a Lenhartz diet. As a matter of fact, treatment for this condition is almost the same as that for a gastroenterostomy.

CANCER OF STOMACH

The symptoms of which the patient will complain are determined by the area in which the growth is located. If it is near the cardiac end where it does not interfere with the functions of the stomach there may be no symptoms at all. If it is in the fundus of the stomach there may be pain, vomiting, loss of weight and anemia. If it is in the pyloric portion, these symptoms are duplicated and there is a greater tendency to vomiting because of the obstruction. Examination of the stomach contents in these cases may reveal a low acid content, no free hydrochloric acid, and often the presence of lactic acid. X-ray examination is sometimes a valuable aid to diagnosis, and, occasionally, the tumor mass may be felt in the upper abdomen in the position of the stomach.

Surgical Treatment of Cancer of Stomach.—The only hope in cases of gastric cancer is partial or complete excision of the stomach (gastrectomy). The operation is rather shocking and the mortality is high. The technic for operation and the post-

operative care are practically the same as that already described in the treatment of gastric ulcer.

DUODENAL ULCER

The condition is quite similar to gastric ulcer, although the symptomatology is slightly different. Pain as a rule occurs an hour or two after meals and is relieved by food. Vomiting is less frequent, but blood in the stools is noticed more often. Loss of weight is not noticed. Gastric analysis reveals a hyperacidity and X-ray examination invariably discloses some deformity of the duodenal cap.

Treatment of Duodenal Ulcer.—This is practically the same as the treatment for gastric ulcer.

SURGICAL CONDITIONS OF INTESTINES

There are many diseases affecting the intestines but the interesting ones from a surgical standpoint are those resulting in perforations and new growths. The intestines may be the seat of perforation as the result of typhoid, tuberculous ulcers, or foreign bodies, or they may be torn by some traumatic condition resulting from a stab or bullet wound. The symptoms are those of peritonitis. The operation at first is in the nature of an exploratory laparotomy. A search is made for the injured intestine and when found the wound, if small, is closed by a purse string suture. If the wounds are multiple, it may be necessary that that part of the intestine be resected, and the two open ends of the gut which have resulted may then be joined together by what is known as an end-to-end, end-to-side, or side-to-side anastomosis. (Fig. 14.) Resection is also employed in conditions of intestinal growths, either benign or malignant.

If the condition of the patient is too poor to warrant the time necessary to anastomose the intestines with suture, a Murphy button may be employed. (Fig. 14 D.) One half is introduced into one open end of the intestine and the intestine drawn over it by suture. The other half is inserted into the other open end of the gut. The two parts of the button are then locked together, thus anastomosing the walls of the intestine.

Post-operative Treatment.—Operations upon the intestines require the same care practically as that following operations upon the stomach, except that cathartics by mouth should not be

given too early, and, when one is given, a mild cathartic rather than a severe purgative should be prescribed. While the patient should be kept free from pain, too much morphine should not be administered, for there is always danger of intestinal paresis due to overdosage of this powerful hypnotic. Should the patient become distended, an irritative enema should be administered, and after the fourth day colon irrigations may be

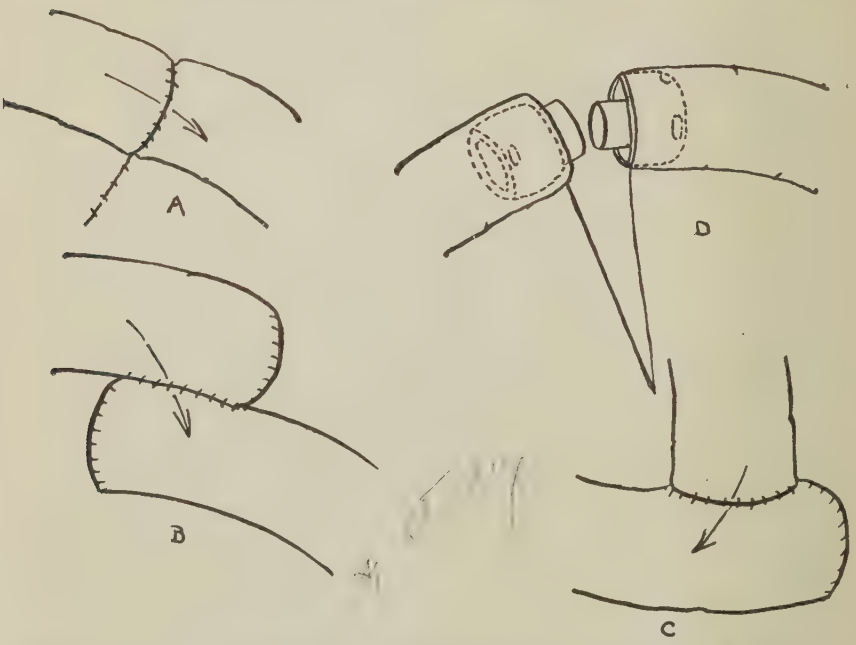


Fig. 14.—Types of Intestinal Anastomoses. *A*, end to end; *B*, side to side; *C*, end to side; *D*, end to end by Murphy button.

employed without any danger. If a Murphy button has been used for anastomosis, all stools should be examined for the presence of the button, and its passage should be immediately reported.

INTESTINAL OBSTRUCTION

This is a condition in which the normal passage through the intestinal tract is interfered with, either partially or completely.

The Causes of Intestinal Obstruction are many and any factor causing either a partial or complete block to the normal pas-

sage of the intestinal contents is a possibility. One of the most frequent causes are bands of tissue *adhesions* occurring soon after or years after the operation. These bands by contraction cause intestinal obstruction.

The intestine occasionally slips into a hernial sac and becomes irreducible and strangulated, or it may twist upon itself, causing a *volvulus*. Occasionally the intestine itself may be narrowed by stricture or new growth, and less frequently a foreign body may become impacted within the lumen, causing a complete obstruction.

The Symptoms.—The pain is usually cramp-like and colicky. The vomitus is quite characteristic. At first it consists of recently ingested food, then gastric contents, then the contents of the duodenum as evidenced by bile, then the sweet, brownish small intestinal secretions, and finally it may even be fecal. It is rarely projectile, but more often of a "spillover type" in which the patient vomits small quantities frequently. Examination of the abdomen, as a rule, reveals distention and occasionally visible peristalsis. The temperature as a rule is normal. *Enemata as a rule are ineffectual.*

Treatment.—Immediately after a diagnosis of intestinal obstruction, an exploratory celiotomy is performed with the hope of finding the cause of the obstruction and relieving it, provided no immediate relief is obtained from enemata.

Ante-operative Treatment.—In all cases of intestinal obstruction it is very essential that the stomach be washed just before giving the anesthetic. This will save a great deal of annoyance later, because the danger of aspirating the foul materials stored in the stomach is reduced to the minimum. If the patient is very weak or greatly shocked it is advisable to administer the clysis of saline either before the operation or at the same time the operation is being performed.

Operation.—Inasmuch as the actual surgical conditions in most cases of intestinal obstruction are not diagnosed until the operation, the operating room nurse should be ready at a moment's notice for anything from an *enterostomy* to an extensive resection. Since these operations demand a complete exploration, there should always be on hand plenty of pads and hot saline to care for the intestines as they are brought out from the peritoneal cavity. If, after the obstructive element

has been found and removed, the distention is still great to the point of paralysis of the smooth muscle of the intestine, an enterostomy might be performed. This is an incision into the bowel for the purpose of inserting therein an L-shaped glass tube known as a Paul's tube, or a simple rubber one. The open end of the glass is connected with rubber tubing which drains into a bottle provided for the escape of the intestinal contents. This operation practically amounts to the formation of an artificial anus.

Post-operative Treatment.—If an enterostomy has been done, the treatment is the same as that prescribed following intestinal injuries. If the tube has been placed in a high portion of the jejunum, peptonized milk, beaten egg and other nutritive fluids may be introduced through it via a catheter entering the descending loop of gut; the original enterostomy tube should be temporarily clamped after the feeding has been introduced. It is very important that these cases should be given plenty of fluid either hypodermically, rectally, or by infusion. The skin about the enterostomy opening should be well protected against the irritating influences of the intestinal contents either by albolenated gauze or Beck's paste, and the contents themselves may be continually aspirated by suction drainage.

INTUSSUSCEPTION

This condition is a form of intestinal obstruction brought about by the telescoping of one portion of the bowel into the other. (Fig. 15.) It is especially common in infants. As a rule the stools contain blood and mucus and the intussuscepted mass is palpable on abdominal examination. The treatment, as a rule, is operative, entailing a reduction of the intussusception, or if the bowel is gangrenous, a resection of the involved portions. There is nothing special in its nursing.

APPENDICITIS

This is one of the most common operations performed today, and the cases in which the nurse will be called upon to assist may be divided into three great groups.

1. Interval or chronic appendicitis.
2. Acute appendicitis without perforation.
3. Acute appendicitis with perforation.

THE INTERVAL APPENDIX

An interval appendix is so called because the operation is performed after an acute attack has passed away and before another acute attack makes its appearance. In other words, it is an acute appendicitis which has subsided, or has become what may be termed a chronic appendicitis.

FIG. 15.—AN INTUSSUSCEPTION OF THE SMALL BOWEL WITH GANGRENE. (Courtesy of Dr. J. J. Westermann.)

Symptoms.—These may vary tremendously from vague digestive disturbances manifested by gaseous eruptions, pain and flatulence, to definite pain localized in the right lower quadrant, the usual anatomical position of the appendix.

Treatment.—After a definite diagnosis has been made, the appendix is removed. The operation is termed appendicectomy or appendectomy.

Ante-operative Treatment.—The routine ante-operative prep-

aration which is described in Chapter XIV is given. The operation is done under gas and oxygen, or gas and ether, or it may be done under local anesthesia.

Operation.—The abdomen is usually opened by a McBurney or oblique incision, or a right rectus; or vertical incision; or a Kammerer incision in which the rectus muscle is pulled toward the median line. The appendix is usually delivered into the wound (Fig. 107), the mesentery is ligated with plain catgut and a purse string suture of linen or Pagenstecher on a straight or curved needle is introduced about the base of the appendix; the base is doubly clamped or ligated and a split pad placed about both clamps. The appendix is then cut between the clamps or ligatures by means of a knife dipped in carbolic acid or by actual cautery. For safety's sake, the stump is again cauterized or carbolized. If the latter procedure is used, it is neutralized with alcohol to prevent the carbolic from eating too deeply. All the instruments coming into contact with the lumen of the appendix are contaminated and should be placed in a separate "dirty" tray. The clamp is then removed; the cauterized stump is grasped with a small pair of forceps and buried by means of a purse string suture, or the ligated carbolized stump may be left free without inversion. The hands are then washed in bichloride, the towels changed, and a reinforcing figure-of-eight suture may be taken. The abdomen is then closed in the usual manner.

Post-operative Treatment.—The patient is given a quarter of a grain of morphine and 1/150 grain of atropine, if necessary. As soon as the patient regains consciousness the gatch is raised one notch. Water is allowed in sips about two hours after the last vomiting, and the usual post-operative routine begun. The sutures are generally removed on the seventh day, and the patient allowed out of bed on the ninth. The bowels are moved on the second or third day by a dose of salts, followed by an enema, if necessary.

ACUTE APPENDICITIS

Rutherford Morrison states that there would be no percentage of deaths from appendicitis if every case commencing with acute pain and developing tenderness and rigidity of the abdomen in the right lower quadrant with a quickening of the pulse were

operated upon within twelve hours. This view is of great importance. It is hard to impress it upon the lay mind, but it is the duty of the nurse to instruct the public upon this subject. Sudden pain in the right iliac fossa with tenderness and slight fever accompanied by nausea or vomiting point, as a rule, to acute appendicitis. In this condition the appendix is acutely inflamed, often gangrenous, and because of this condition may

FIG. 16.—A GANGRENOUS APPENDIX CONTAINING A FECALITH. (Courtesy of Dr. Morris K. Smith.)

perforate and give rise to either an abscess or general peritonitis (see Fig. 16).

Treatment of Acute Appendicitis.—While most surgeons are agreed that all cases of acute appendicitis should be operated upon as soon as the diagnosis is made, there are some patients who, in spite of all persuasion, refuse immediate operation. Then again, when there is extensive pulmonary tuberculosis, bad cardiovascular disease, or diabetes, the *expectant treatment* might be followed. Of course this is dangerous. The family should be warned of the consequences, and the patient carefully

watched. Blood counts should be taken often, and should the pulse rate and the number of white blood cells increase, although the temperature does not vary, an operation should be performed, even if local anesthesia has to be resorted to. If the non-operative treatment is to be pursued, the patient should be put to bed, the knees flexed with a pillow underneath them and ice bags applied to the abdomen. The bag should be left on for two hours and off for one. Nothing should be given by mouth while there is vomiting. After the nausea has subsided, water may be given in teaspoonful doses. This may be augmented later by albumen water, milk and lime water, broths and meat juices. Enemas should not be given promiscuously, and if at all, in small amounts and with great care. When the acute symptoms have subsided a saline cathartic may be given by mouth.

Ante-operative Treatment.—Fortunately, most of these cases are generally operated upon as soon as the diagnosis is made. Naturally no cathartic is ever given by mouth, but, if the patient is in good condition, the lower bowel may be cleansed by a soap-suds enema. This does much to render post-operative recovery smooth and uneventful.

Operation.—The procedure is the same as that in interval appendicitis and if the appendix has not ruptured, the abdomen is sewed tightly without drainage.

Post-operative Treatment.—The treatment is identical with that prescribed for interval appendicitis, except that occasionally eight ounces of tap water might be administered by rectum and the patient ordered in Fowler's position if there was free fluid in the pelvis. (The Fowler position is a semi-erect position obtained by either elevating the head of the bed and flexing the knees with a pillow or by adjusting the gatch bed.) A cathartic is generally given on the third or fourth day. If everything progresses smoothly the patient is allowed up on the ninth day.

ACUTE APPENDICITIS WITH PERFORATION

This is a condition of acute appendicitis complicated by a perforation which either forms an abscess about the appendix or results in a diffuse spreading infection of the peritoneum (peritonitis). The symptoms are those of acute appendicitis, only more severe.

Ante-operative Treatment.—The treatment is the same as that which has been outlined for acute appendicitis.

Operative Treatment.—The appendix is removed and the stump inverted whenever possible. The abscess cavity is freed of its pus, and a drain is introduced into the cavity or into the lower pelvis. The drainage material may be any one of the substances discussed on pages 357-360.

Post-operative Treatment.—The treatment is similar to that of acute appendicitis, except that the patient is usually more acutely ill, and occasionally shocked. The patient is placed in Fowler's position and saline is given liberally by Murphy drip. Dressings are generally done daily. Recently some of these cases have been treated by the Carrel-Dakin method (Chapter XX). The patient is kept in bed until the drainage tube has been removed and the wound is practically healed.

COMPLICATIONS OF OPERATIONS FOR ACUTE APPENDICITIS

The complications apt to occur are those which follow any abdominal operation. *Peritonitis* of a spreading nature is always a possibility. *Severe wound infections* with fascial slough are not uncommon. Those cases in which there is a persistently high temperature and an increased leukocyte count should make one suspect a *secondary abscess*. If a mass is felt through the rectum or vagina, definite proof of a secondary pelvic abscess is established. This condition does not always demand operation to establish drainage of the abscess, as in some cases the mass might be absorbed by efficient hot colon irrigations given at four-hour intervals. If it persists it may be drained through the rectum or vagina.

Occasionally a dressing which has been previously pusy may be covered with blood. This is evidence of a *secondary hemorrhage*. The attending surgeon should be called without any loss of time, and the wound packed temporarily to control the bleeding. The bleeding vessel is then sought and ligated.

Now and then, quite soon after operation, the dressing may be covered with feces; a sign that the dreaded complication of *fecal fistula* has occurred. All drainage tubes are removed, and the wound is treated as any enterostomy or colostomy. Dressings are changed at frequent intervals, and the skin is protected and kept scrupulously clean. Fortunately, most of these

cases heal eventually, although convalescence is long and protracted.

Recently, cases of appendicular abscesses have been treated by the Carrel-Dakin method. The technic of its administration is described in Chapter XX.

THE COLON

The colon, like other organs, may be subject to acute and chronic inflammations, obstructions and new growths.

Inflammations of the Colon.—Those of the acute variety may be classified under the heading of acute colitis, either mucous or ulcerative, depending clinically upon whether the stools contain mucus or an excess of blood. It is an extremely distressing condition, characterized by intestinal colic and by the passage of innumerable loose, watery, bloody stools. There is usually great loss of weight, anemia and impaired vitality. As a rule these cases can be treated medically. The patient is given a bland constipating diet, limited fluids, opium to rest the intestines and colon irrigation of various antiseptic substances. Occasionally, if the condition becomes quite severe, it may be necessary to rest the colon by shunting the intestinal contents through an ileostomy. In this way, none of the fecal material passes the colon and the colon secures a rest. In severe cases, however, removal of the colon may be necessary.

Chronic Inflammations of the Colon.—These may be either the aftermath of the acute variety, or due to tuberculosis. The diagnosis of the latter condition as a rule is made on the history, progressive emaciation, the presence of a palpable abdominal tumor and signs of low grade intestinal obstruction. Occasionally the symptoms of ulcerative colitis may be present. A careful examination of the stools may show tubercle bacilli, and the X-ray examination may be helpful. If the disease is localized to a certain part of the colon, as for example the cecum, a partial resection of the involved bowel may be possible. If it is diffuse, only the routine medical treatment for tuberculosis is indicated.

New Growths of the Colon.—These are usually carcinomata and the condition is diagnosed from the intermittent intestinal obstructive symptoms. Physical examination may reveal an abdominal mass. An X-ray barium enema may reveal a definite lesion.

THE TREATMENT OF NEW GROWTHS OF THE COLON

If the obstruction is acute, the bowel must be drained by the establishment of an artificial anus either by (*a*) cecostomy or (*b*) colostomy, depending upon the location of the tumor. If the condition is chronic, however, a partial or complete colectomy may be performed with or without a preliminary cecostomy or colostomy; or, if the condition is inoperable, a permanent cecostomy or colostomy may be all that is necessary.

Cecostomy.—In this procedure, the intestinal contents are drained externally through an opening made in the cecum. A McBurney or right rectus incision is made. The cecum is sutured directly to the peritoneum and brought out on a level with the skin. After adhesions have been effected and the cecum has been sealed off from the general peritoneal cavity, it is opened with a cautery and the feces permitted to escape. If it is impractical to deliver the cecum into the wound, or if the surgeon prefers, a rubber tube is inserted into the cecum and buried by means of purse string sutures and the tube brought externally. The post-operative care of these cases will be considered under colostomy.

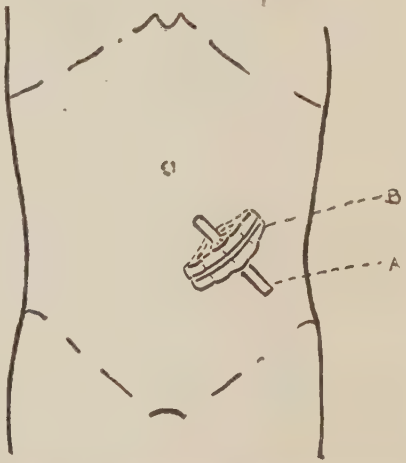


FIG. 17.—COLOSTOMY BEFORE BEING INCISED. *A*, glass rod passed through mesentery of colon; *B*, exposed loop of colon.

Colostomy.—A colostomy is an incision into the colon for the purpose of short-circuiting the fecal contents and of establishing an artificial anus. The operation of colostomy is simple. The desired part of the colon is brought into the wound, then a glass tube is passed through the mesentery of the colon, so as to prevent the colon from slipping back into the peritoneal cavity. (Fig. 17.) The exposed colon is then sealed off from the peritoneal cavity by suturing it to the parietal peritoneum.

Post-operative Treatment.—The colon is covered with vaselinated gauze, and a sterile dressing applied. The patient is fed but little and to further constipate the patient a pill of

opium, 2 grains, may be given for the first four or five days. About the third or the fourth day the exposed loop of colon is opened with the aid of an actual cautery, establishing the artificial anus. There are several factors that are of importance in caring for a patient with a colostomy. If possible, an attempt should be made to regulate the movement of the bowels and the food given should be of a constipating variety, so that when the bowels move, the movement should be hard and formed, instead of loose and diarrheal. The skin surrounding the colostomy is apt to become irritated. It should be protected by an ointment of bismuth subnitrate and zinc oxide, to which may be added a little oil of eucalyptus.

If at any time, however, there is no movement from the artificial anus, and general distention is evident, there should be no hesitancy in giving an enema through the colostomy opening. It is not advisable to give cathartics by mouth, especially the saline variety, for it should always be remembered that these patients have practically no control of their bowel movements, and watery stools cause a constant soiling of their dressings. After a while the patient may wear a colostomy bag, a rubber appliance which is worn over the artificial anus to collect the feces. This is held in place by straps. (Fig. 18.)

Fig. 18.—Colostomy Bag.

Colectomy, Partial and Complete.—Resection of the colon may be performed as a primary operation, especially when signs of acute intestinal obstruction are absent. A resection of the large intestine is quite similar to that of the small. If it is necessary to remove the cecum and part of the ascending colon, the terminal ileum is anastomosed to the transverse colon. This is known as an *ileocolostomy*. On the other hand, if part of the transverse colon is removed and either end-to-end or side-to-side anastomosis of the colon is performed, it is spoken of as a *colocolostomy*. If the entire colon is removed, the ileum may be anastomosed to the sigmoid or to the rectum, *ileosigmoidostomy* or *ileoproctostomy*. Occasionally, if the tumor of the colon does not produce really acute obstruction, and if it is surgically impossible to remove, it is not disturbed, but instead the small intestine is divided and the proximal part anastomosed to the

colon, distal to the tumor. In this way, the intestinal obstruction is relieved and the patient is not burdened with an artificial anus. The nursing entailed in all these cases is practically the same as that outlined for intestinal resections, both from the ante-operative and operative standpoint. The only difference is that these cases must be carefully cleansed with castor oil for at least three days before operation and the colon must be cleansed by colon irrigations for about five days before operation. Post-operatively, all rectal medication and treatments are prohibited for as long as is possible.

THE RECTUM

The important conditions from a surgical standpoint occurring in or about the rectum are: (1) ischiorectal abscess, (2) fistula in ano, (3) hemorrhoids, (4) cancer of rectum.

ISCHIORECTAL ABSCESS

An abscess about the rectum is like an abscess in any other part of the body except that it might communicate with the rectum, and if not treated properly a fistula might result. This is a tract connecting the skin and rectum. For this reason it is always better to incise and drain the abscess as soon as possible, packing the abscess cavity and permitting it to granulate from the bottom.

FISTULA IN ANO

This may be the result of a poorly treated ischiorectal abscess. It is important in treating the fistula that the tract be excised in its entirety by careful and complete dissection.

Ante-operative Treatment.—A cathartic is given twenty-four hours before operation, usually an ounce of castor oil. Four hours before operation, the lower bowels should be thoroughly washed with a warm soapsuds enema. At least three of these should be given. If the third return is not clear, more enemata should be administered until the rectum is absolutely cleansed. This rectal treatment should not be administered just prior to operation, because much of the liquid material is apt to be retained and the surgeon is hampered in his work by the escape of rectal fluid. Some surgeons inject the fistulous tract with a solution of methylene blue, a dye which colors the tract,

making its ramifications evident. This may be done before or after the anesthesia has been begun.

Post-operative Treatment.—Until the patient regains consciousness, the legs should be tied together. In operations about the rectum, retention of urine is apt to result and great care should be taken lest the bladder become distended. The diet should be constipating and to further constipate the patient a pill containing opium is given three times a day. The bowels should be moved upon the fourth day, and, after the movement, the parts washed with soap and warm water, and fresh packing introduced. The packing must be changed each time the bowels move, if stained with fecal material. The dressing of these cases is exceedingly important. If the packing of the cavity is left to the nurse, she should very conscientiously see that it is firmly and securely introduced into the depths of the granulating cavity. The proper healing will do much to prevent a recurrence of the fistula.

HEMORRHOIDS

Piles are simply dilated veins about the rectum. They are divided into the internal variety (those situated above the internal sphincter), and the external variety (beneath the external sphincter). Piles may be a source of annoyance by their protrusion and bleeding, or the veins may become inflamed and thrombosed.

Ante-operative Treatment.—The treatment does not differ from that of an ischiorectal abscess.

Operative Treatment.—After the patient is anesthetized, the sphincter ani is dilated manually as a preliminary step to the operation. This gives a better exposure of the interior of the rectum, and by paralyzing the sphincter, the after pain is less, since the muscle about the rectum cannot contract.

The piles are removed by (1) simple excision, (2) clamp and cautery, or (3) by ligating the pile-bearing area. After the operation has been performed, some surgeons insert a rectal tube around which have been wrapped two or three layers of vaselinated iodoform gauze. The advantages of this are twofold: it prevents hemorrhage and it enables the accumulated gas to escape; but it has the great disadvantage of being rather painful and uncomfortable for the patient.

Post-operative Treatment.—The same measures are taken as for an ischiorectal abscess, except that on the fourth day, when the cathartic is given, immediately before the patient moves the bowels, six ounces of warm olive oil are introduced into the rectum through a tube. This softens the accumulated feces and lubricates their passage. Following the movement of the bowels, the patient should be instructed to take Sitz baths, night and morning. These are comforting and are very helpful in healing the denuded areas about the rectum. For a period of two to three weeks after operation, the patient should receive nightly an ounce of licorice powder, as it is essential that the bowels be kept soft and loose. The patient should be put on an anti-constipation diet, a good example of which may be found in Chapter XIII on diets.

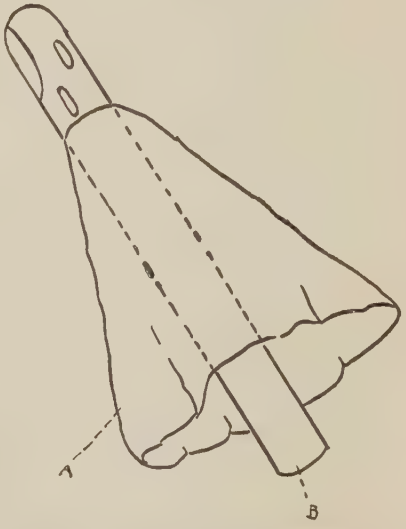


Fig. 19.—Tube "En Chemise." *A*, layer of gauze attached to rubber tube *B*.

Complications.—The great danger in a hemorrhoid operation is that of hemorrhage. If a patient begins to faint and to show the signs of hemorrhage, even though no blood is visible externally, which might happen if a rectal tube is not inserted, the attending surgeon should be immediately summoned. The patient is placed under anesthesia, a tube "en chemise" is introduced and the rectum firmly packed. A tube "en chemise" is simply a rubber tube to the rectal end of which gauze is attached. (Fig. 19.) It is inserted into the rectum and packing is introduced between the tube and gauze, thereby exerting pressure on the bleeding area. Sometimes the bleeding point itself may be ligated.

CANCER OF RECTUM

As in other locations, cancer in this region, provided it has not progressed too far, demands excision. The symptoms may be

simply those of hemorrhoids together with a discharge of blood and pus from the cecum. Rectal examination by the finger or proctoscope may reveal the typical hard fungating type of carcinoma (see Fig. 20). The rectum may be excised by way of

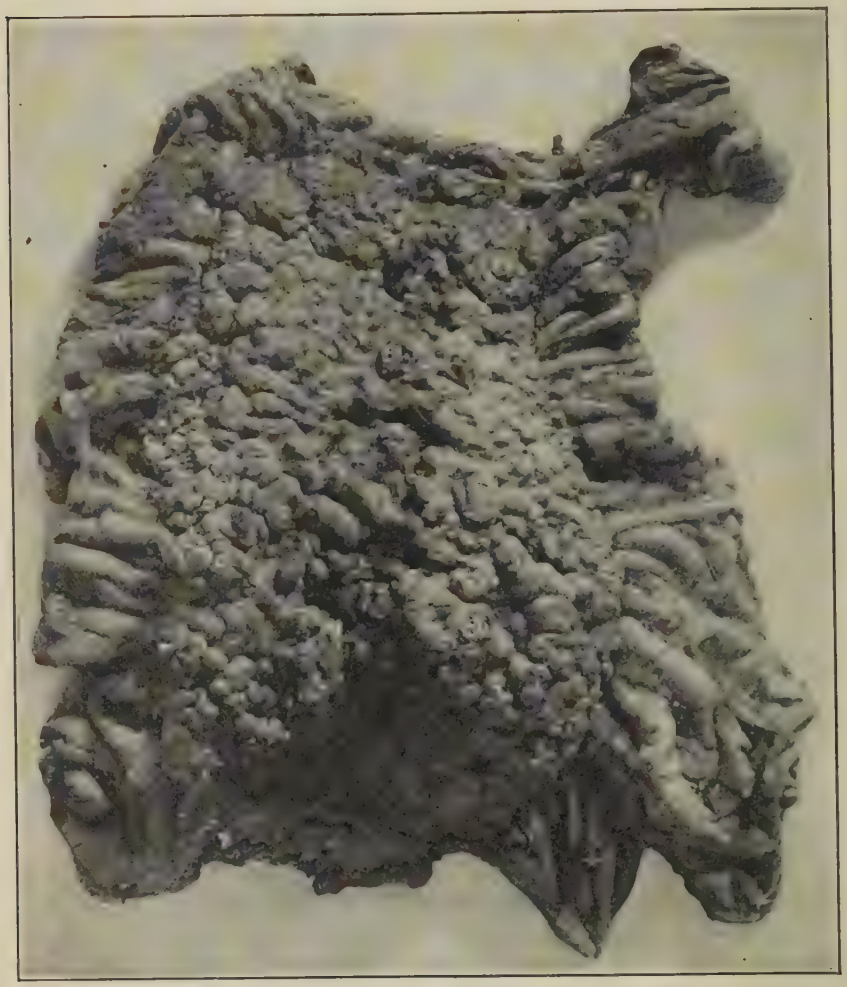


Fig. 20.—A Carcinoma of the Rectum. (Courtesy of Dr. Walton Martin.)

several routes,—by the perineal or sacral route, by the vagina, through the abdomen, or by a combination of these. As a rule any excision of the rectum is preceded by a preliminary colostomy or cecostomy. The technic of this has already been described on page 93.

Excision of Rectum by Perineal Route.—The patient is placed in the lithotomy position (see Fig. 89, page 336), the anus is sewed up, and the rectum is dissected from the surrounding tissues until the upper limit of the growth is reached, and then it is excised.

Excision of Rectum by Sacral Route.—The patient is placed in the Kraske, or reversed Trendelenburg position (see Fig. 87, page 335), and as a preliminary, the coccyx and a portion of the sacrum are removed. This affords freer access to the rectum, and the rectum is dissected freely and excised, and a sacral anus established.

Excision of Rectum through the Vagina.—In this operation the posterior wall of the vagina is used as a means of attack in delivering the rectum and excising it.

Excision of Rectum by Combined Method.—This operation consists of opening the abdomen and doing the operation as far as possible from above. After the tumor has been removed the lower end of the bowel is closed temporarily and the upper end of the bowel is delivered into the wound to serve as a colostomy opening. The lower segment is finally excised by the perineal route, or by one of its modifications.

Occasionally after opening an abdomen, a tumor is found so located that by immobilizing the sigmoid from above, the tumor may be pulled through a Kraske incision. The tumor is then excised and an end-to-end anastomosis of the rectum made. In this way the sphincters are preserved and the distal rectal segment is anastomosed directly with the proximal sigmoid loop. In these cases, when the wound heals, the patient has control of the bowel movement. The colostomy or cecostomy which may have been performed previously may now be closed.

None of the aforementioned operations calls for any special nursing. They are, however, attended with a great deal of shock, and the nurse should be ever ready to institute those proceedings which she has learned to overcome this condition.

THE LIVER AND BILE DUCTS

Certainly the most frequent affection of the liver and the one which most concerns the nurse is that of gallstones (cholelithiasis). In this condition, the gall bladder or any of the bile ducts of the liver may be the seat of stones. (Fig. 21.) It is true

that these stones may lie in the gall bladder and never cause any symptoms. But when the stone leaves the gall bladder and becomes impacted or caught in some of the ducts—for example, the cystic or common bile duct—symptoms of gall bladder colic ensue. If the stone is impacted in the cystic duct, the gall bladder may become slightly dilated, with resulting pain and tenderness in that region; if the stone becomes impacted in the common duct, inasmuch as the flow of bile is impeded on its way to the intestine, there is *jaundice* which may be very marked. As a

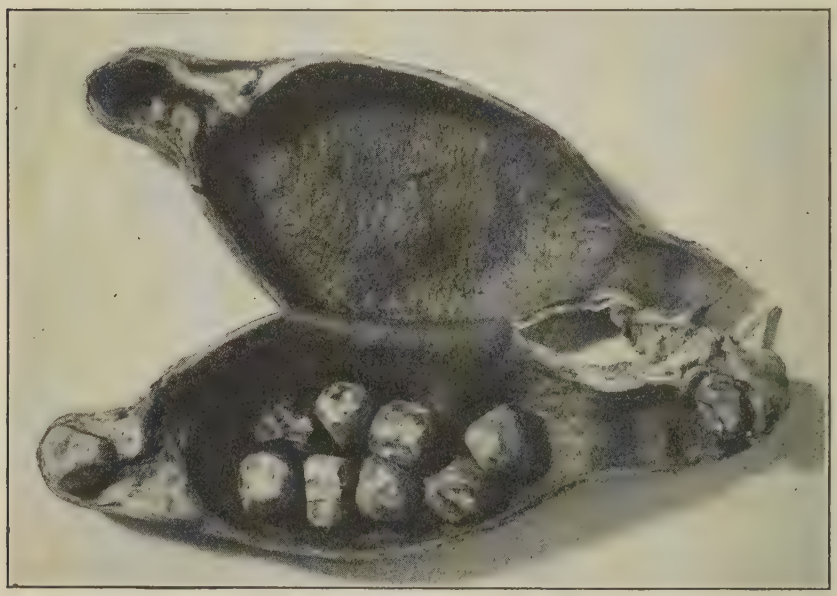


Fig. 21.—A Chronically Inflamed Gall Bladder Containing Gall Stones. (Courtesy of Dr. Edward D. Truesdell.)

result of the jaundice, and no passage of bile into the intestine, the stools are white, clay-colored, and foul-smelling; the urine is dark-brownish in color; and the skin is yellow, due to the deposition of the bile pigment in the skin itself, which also causes itching. Hemorrhages are quite frequent.

Recently diagnostic aid has been given in this condition by means of the duodenal tube and X-ray of the gall bladder. The duodenal tube, which is swallowed, eventually passes into the duodenum. Its presence in the duodenum may be determined by the fact that the aspirated contents are alkaline in reaction.

Several ounces of magnesium sulphate are then injected into the bowel and this causes a relaxation of the sphincter which guards the common bile duct and bile is discharged into the duodenum. By aspiration, this bile may be withdrawn and collected. The first bile aspirated is the so-called "A" bile, and comes from the common bile duct. The second bile, "B" bile, comes from the gall bladder and the remainder of the bile is "C" bile from the liver.

Examination of these various bile specimens obtained by aspiration through the duodenal tube, will give some insight as to existing pathological conditions. The "B" bile which comes from the gall bladder is naturally the most important. If it contains pus cells and bacteria, it may be assumed that an inflammation of the gall bladder, *cholecystitis*, is present. On the other hand, if no "B" bile is obtained, it is highly probable that the cystic duct is occluded, possibly by a stone. These findings may be checked by X-ray examination of the gall bladder (*cholecystography*) by giving the patient some capsules containing sodium tetrachlorphenolphthalein, a dye which is excreted by the bile and which, when filling the gall bladder, casts a shadow on an X-ray plate. Through this medium, not only can gall stones be detected, but the size and emptying capacity of the gall bladder can be estimated.

CHOLECYSTITIS AND CHOLELITHIASIS

The Symptoms of cholecystitis and cholelithiasis occur mainly in women who have had several pregnancies and are inclined to obesity. The symptoms are those of vague indigestion, unless a gall bladder colic is present, during which there may be terrific cramp-like pains in the right upper quadrant, radiating to the right shoulder and scapula. Jaundice is not present, as has been previously stated, unless the stone causes an obstruction to bile flow in the common duct. Temperature is only present when there is infection, as in an acute cholecystitis, or empyema of the gall bladder.

MEDICAL TREATMENT

During an attack of colic, the patient is given large doses of morphine and placed in bed. Over the region of the gall bladder it is advisable to place hot applications, either poultices or

stupes. Following these attacks the patient should have a light diet with the minimum amount of fat. Intestinal elimination should be kept free by using salts, especially sodium phosphate. There is a popular superstition that consuming olive oil aids the free passage of gall stones. This has no scientific foundation. Medical drainage of the gall bladder through a duodenal tube has been strongly advocated.

SURGICAL TREATMENT

Operative measures are employed when there have been repeated attacks of colic, when the stone has become impacted, or when the gall bladder is acutely inflamed or filled with pus.

Ante-operative Treatment.—The ante-operative treatment is of extreme importance in jaundiced cases because jaundice is one of the factors which prevents or delays the clotting of blood. Naturally, pre-operative measures must be taken to ensure a lowering of the coagulation time. This may be accomplished (previously mentioned in detail in Chapter III) by the administration of calcium lactate, horse serum, or transfusion.

The position of the patient on the operating table is important because the gall bladder and its passages lie deep within the abdomen, and every effort must be made to make them as accessible as possible. This is attained by placing the patient on the table so that the gall bladder bridge may be elevated, thus forcing the liver forward; or a sandbag may be placed in the region of the eleventh or twelfth ribs. Both methods yield good results. (See Fig. 82, page 331, and Fig. 83.)

Operations.—The operations which may be performed upon the gall bladder and its ducts are cholecystotomy, cholecystostomy, cholecystectomy, choledochotomy, and cholecystenterostomy. (See Fig. 110.)

Cholecystotomy.—This is an operation in which the gall bladder is opened, the stones removed, and the original incision in the gall bladder closed. It is not often performed because the gall bladder generally requires drainage.

Cholecystostomy.—In this operation the gall bladder is not removed, but it is drained; the drainage is placed into the gall bladder itself by burying the tube with a purse string suture.

Cholecystectomy.—This procedure is the most frequent; it involves the removal of the gall bladder and the ligation of the cystic duct and cystic artery.

Choledochostomy.—In those cases in which the stone lies impacted in the common duct, the removal of the stone by incision of the duct followed by drainage is spoken of as choledochostomy.

Cholecystenterostomy.—Sometimes the obstruction of the common duct is such that it cannot be removed; for example, stricture of the duct, either benign or carcinomatous. If the patient is suffering from intense jaundice, an attempt is made to short-circuit the bile. This is done by establishing an anastomosis between the gall bladder and the stomach or between the gall bladder and the small intestines. This operation is spoken of as cholecystgastrostomy or cholecystenterostomy.

Post-operative Treatment.—Operations in and about the gall bladder are accompanied by a great deal of shock, and as most operations involving the upper abdomen are attended by a large percentage of pneumonias, all means must be taken to insure perfect care of the patient, to prevent him from being chilled or caught in draughts.

In those cases in which the gall bladder or common duct is drained, the end of the drainage tube should be inserted into a bottle so that the bile may be collected, its character observed, and the amount estimated. Occasionally, bile will leak along the side of the drainage tube, resulting in a general soaking and discoloration of the dressing. If this discharge is very marked, the superficial layers of the dressing may be removed and fresh compresses applied.

It is important that all urine should be examined closely for the presence of bile, and that the stools be sent to the laboratory to determine whether bile is present. While the gall bladder is draining, the patient must be placed upon a diet which is poor in fat, because the bile salts which aid in the saponification of the fats are missing.

In certain cases in which the clinical course makes it apparent that the patient is suffering from a want of bile, the bile should be collected and refed through a stomach tube. If this is not practical the patient should be given ox bile by mouth.

SURGICAL CONDITIONS OF THE LIVER

The conditions which commonly involve the liver from a surgical standpoint are injuries, abscesses and cirrhosis.

Injuries to the Liver.—The liver may be torn by direct or indirect violence resulting in hemorrhage. If the bleeding is severe as manifested by physical signs, an immediate laparotomy should be performed and the wound packed with gauze or the tear should be sutured with mattress sutures of chromic gut passed on a round, non-cutting liver needle.

ABSCESS OF LIVER

This may be of pyogenic origin, or the direct result of amebic dysentery. These abscesses may be opened and drained directly through the abdomen, or if the abscess is high, an operation may be performed through the posterior lateral area of the chest. The parietal and visceral pleurae are sutured together, and after adhesions have appeared, so as to seal off the pleural cavity, the liver is drained through this area. In this way no pus flows through the abdominal or peritoneal cavity, or through the pleural cavity. This operation is done in two stages, the first being a partial resection of the rib, with the suturing of the parietal and visceral pleura; the second is the drainage of the abscess through the area of the adhesions.

CIRRHOSIS OF LIVER

As this condition is associated with a filling of the peritoneal cavity with fluid (ascites), and as it is presumably due to an obstruction of the portal circulation, an attempt is made to establish a collateral circulation by the Talma operation (omentopexy).

Twenty-four hours prior to operation, an ordinary paracentesis abdominalis is done. The patient is then operated upon, and a portion of the omentum brought through the anterior abdominal walls in the midline and sutured to the subcutaneous tissues. In this way the omental veins will establish collateral circulation with the internal mammary vein, thereby lessening the strain on the portal system.

The one important factor in post-operative treatment is that when a patient strains, the abdomen should be firmly held so as

to prevent further evisceration of the abdominal contents along with the omentum.

SURGICAL CONDITIONS OF THE PANCREAS

The pancreas may be in a state of acute or chronic inflammations, cyst formations, and carcinoma.

Acute inflammations of the pancreas manifest themselves by severe abdominal pain, accompanied by nausea and vomiting, some cyanosis and usually shock. If the diagnosis is made, operation is rarely performed and the patient is treated expectantly. However, if the patient is operated on, the gall bladder is invariably drained. This is done on the theory that the bile, by retrogradely filling the pancreatic duct, has produced the pancreatitis. By this procedure, the pancreas, which is now free from the irritating effects of the bile, will be rested and the inflammatory process may subside.

Chronic Inflammations of the Pancreas.—As in carcinoma of the head of the pancreas, the common bile duct is pressed upon by the inflamed pancreatic tissue as it enters the second portion of the duodenum. The narrowing of the duct, which at times may result in a complete stenosis, gives rise to jaundice with its attendant symptoms. The only operations performed are those of a palliative nature. They simply consist in relief of the jaundice, either by external drainage of the bile, through cholecystostomy or by internal drainage of the bile; *i.e.*, anastomosis between the gall bladder and the small intestine, a cholecystenterostomy (see page 103). The nursing procedures employed in these cases are similar to those which have been described in the operations of the biliary tract (see page 99).

Cysts of the Pancreas may reach an enormous size and give rise to symptoms due to their pressure on the surrounding organs. The operation is usually one of drainage, inasmuch as these cysts are regularly irremovable. In order to prevent the reaccumulation of fluid in the cyst, the cyst wall is usually sutured to the skin of the abdomen (marsupialization), so that it may discharge its contents externally rather than refill internally. This will necessitate the wearing of a small dressing to absorb the secretions for a long period of time, often as long as the patient lives.

THE SPLEEN

This organ is of interest surgically because it is subject to trauma and intimately connected pathologically to certain diseases in which there is a destruction of red blood cells.

Rupture of the Spleen.—The spleen is occasionally ruptured due to trauma, and, as a result, intraperitoneal hemorrhage results. When the diagnosis is made, an exploratory celiotomy is performed, and, if conditions warrant, a splenectomy is performed. This operation as a rule is not difficult. A left rectus incision or one parallel to the left costal arch is made. The spleen is then delivered and care is always taken in ligating the splenic artery and splenic vein so that no injury is done to the pancreas or stomach, which lie close by. No special nursing is required in the care of these patients.

Indications for Splenectomy.—In addition to removal of the spleen for rupture, splenectomy is performed for certain types of purpura (a disease characterized by hemorrhages into the skin and bleeding from the various body orifices). It is really amazing how this condition is immediately cured as soon as the splenic pedicle is ligated and the spleen removed. A type of jaundice of a hereditary character known as hemolytic family icterus is cured by this operation. There are other medical diseases for which splenectomy is performed, but these are so unusual that no mention is necessary here.

HERNIA

A hernia, or rupture, may be defined as the protrusion of an organ or part of an organ or other structure through the wall of the cavity normally containing it. The rupture is named from the region in which it appears. There are many locations where, because of certain mechanical weaknesses, hernia is quite common. It occurs very frequently in the inguinal region.

VARIETIES OF HERNIA

Inguinal hernia (Fig. 22) is a form of rupture that occupies the inguinal canal either partly or entirely; if it occurs, the condition is spoken of as an indirect hernia. A hernia making its appearance almost directly into the external abdominal ring is called a direct hernia.

Under ordinary conditions, the contents of the hernial sac will

disappear into the abdominal cavity when the individual is at rest, to reappear when the intra-abdominal pressure is increased, as during coughing or arduous physical labors. A hernia which disappears is known as reducible; if because of adhesions this

FIG. 22.—AN IRREDUCIBLE INGUINAL HERNIA. (Courtesy of Dr. H. H. M. Lyle.)

does not occur, it is irreducible. There are several varieties of the irreducible group: *Incarcerated*—a type of obstructed hernia containing bowel in which the passage of fecal material is arrested but the circulation of the intestine is unimpaired. *Strangulated*—a hernia in which not only the bowel is obstructed but also the blood supply. If this condition is not operated upon very soon after its incipiency a gangrene of the obstructed loops of intestine will result.

Other varieties of hernia are femoral, which is a rupture in the region of Scarpa's triangle, occurring through the femoral ring; umbilical, which is a protrusion through the abdominal wall in the region of the umbilicus. (Fig. 23.) Then there are hernias which occur following operation, especially in those cases in which the abdominal wall has become weakened. These are known as post-operative hernias.

Occasionally, especially in children, the hernial sac may contain the testicle; this is known as a congenital hernia and always accompanies an undescended testis. In this condition the testicle is not in the scrotum but within the abdomen or inguinal canal.

Treatment.—Hernia may be treated conservatively with a suitable apparatus or truss (an appliance made to exert pressure over the hernial opening so as to keep the contents of the sac reduced) but since the public is becoming educated to the wonderful results obtained by surgery, it is almost always treated radically by operation. There are two important principles underlying all hernia operations: the obliteration of the hernial sac, and the closure of the channel along which the hernia protrudes.

Ante-operative Treatment.—The same ante-operative routine is employed as for all chronic cases. (Chapter XIV.) The lower abdomen and genitals are shaved and a sterile dressing is applied. Care must be taken that the external genitalia are not painted with iodine. In the operating room, the operative field is repainted with iodine, and the penis and scrotum are enclosed in a sterile, wet bichloride towel.

Operation.—In inguinal hernia an incision is made over the external ring upward along Poupart's ligament. The external ring is identified, and the surgeon calls for a grooved director on which he cuts the fascia of the external oblique. The sac is

Fig 23.—A Recurrent Umbilical Hernia. (Courtesy of Dr. H. H. M. Lyle.)

then identified, dissected free, its base transfixed and ligated with catgut on a curved needle. The repair of the hernia, "the closure of the channel," is then performed, the suturing being done with chromic catgut, kangaroo tendon, etc. A spica bandage (Fig. 164) in addition to adhesive plaster keeps the dressing in place. A plaster spica is often used in children where immobilization is absolutely essential. If the child is very young, the spica may be coated with shellac so as to render it impervious to urine and feces.

Post-operative Treatment.—As soon as the patient reaches the ward, a pillow is placed under the knees, and as soon as he is conscious, a Bellevue bridge is applied across the thighs to support the scrotum.

The cathartic is given on the second day and, as a rule, patients are kept in bed for two or more weeks. For the first twenty-four hours catheterization may be necessary.

In cases of incarcerated and strangulated hernias after the sac has been opened, the surgeon will cover the bowels with moist warm saline towels for about ten minutes, and if there is no evidence of real damage, and their color is good, the intestines are reduced into the peritoneal cavity. If the intestines are gangrenous, an intestinal resection will have to be done. These cases are then treated like any other case of intestinal resection.

In all cases of hernia it is very important to impress upon the mind of the recently operated that for a few months, at least, all physical exercise should be of the mildest kind, and that any sudden strain must be avoided.

Gallie Operation for Hernia.—In recurrent hernias or those in which the fascial structures are of poor quality, longitudinal strips of fascia lata are taken from the lateral aspect of the thigh and used as suture material. Special needles are made to hold this large fascial suture. The theory is that this fascia will incorporate itself with the aponeurosis through which it has been passed and act as a sort of fascial transplant or graft. The strictest asepsis is necessary throughout this procedure and the thigh should be thoroughly cleansed and shaved so that the fascial strips may be cut without difficulty. The wound in the thigh is always closed without drainage.

CHAPTER VI

THE SURGERY AND SURGICAL NURSING OF THE RESPIRATORY SYSTEM

The organs which constitute the respiratory system may be classified as the accessory and the main groups.

Accessory System:
1. Nose { nares, septum, sinuses
2. Mouth
3. Pharynx { nasopharynx, oropharynx

Main System:
1. Larynx
2. Trachea
3. Bronchi
4. Lungs and Pleura

The mouth and pharynx are discussed under the Alimentary System.

NOSE

The nose serves the very important function of filtering, warming, and moistening the air. In addition to aiding the sense of smell, it also gives the voice some of its qualities. The diseases which affect the nose are many and well known. The only pathological conditions of interest here are those resulting from obstruction from a deviated septum or hypertrophy of the turbinates (bones in the nares) and infections of the various sinuses.

Deviated Septum.—In this condition one or both sides of the nose are occluded by a deformity of the nasal septum, and an attempt is made to remove the obstructing cartilage by a submucous resection preserving the mucous membrane of the septum. After the operation has been completed, each nasal cavity is packed with strips of sterile gauze. The packing is removed after twenty-four hours.

Hypertrophy of the Turbinates.—The turbinates are small bones, three in number, found along the outer wall of each nasal

cavity. Occasionally these increase in size and obstruct free respiration. They may be reduced by chemical irritants or cautery or partially removed by cutting them with a wire snare. Occasionally, hemorrhage may follow the removal of part of the turbinate bones. This may be controlled by spraying in some adrenalin solution, syringing the nose with hot water (temperature about 120 degrees) or plugging the nose with cotton. Most of these operations are done under novocain.

Sinusitis.—The sinuses of the nose may be frequently involved during a cold, and very often the frontal, ethmoidal, sphenoidal sinuses, or the antrum may be the seat of infection. This condition is recognized by pain in the region of the sinus involved, discharge, and tenderness on pressure over the sinus. The treatment consists in establishing free drainage. In the case of the antrum of Highmore, this is done by punctures of the sinus and daily irrigations through the nose.

THE LARYNX

Those conditions affecting the larynx which are of interest from a surgical viewpoint may be divided into those of foreign bodies lodged in the larynx, and new growths. There are many other conditions, such as acute and chronic inflammations, syphilis and tuberculosis, which require attention, but they fall into the province of the laryngologist, and he personally gives most of the necessary treatments.

FOREIGN BODIES

The most common way for foreign bodies to lodge either in the larynx or further down in the trachea is for an individual to swallow them. The symptoms which are produced will vary according to the size of the body and its location in the respiratory tract. Sometimes they are expelled by coughing; at other times they may remain. Cases are not rare in which the material has been of sufficient bulk to occlude the larynx, with death immediately ensuing from asphyxiation.

Treatment.—Slapping the patient on the back or inverting him may dislodge the foreign body. If this is not successful, it may be removed with forceps either under direct vision, or with a Killian or Jackson laryngoscope. These are electrically illuminated telescopic instruments designed to enter the larynx. The

pharynx and larynx may first be cocainized, or the patient may be placed under deep anesthesia. The laryngoscope is passed through the mouth and pharynx into the larynx, the head and neck being bent backward, and the foreign body removed through the instrument.

Occasionally, the condition is so urgent that to relieve the asphyxia, an opening must be made into the trachea below the point of obstruction, so that air may enter the lungs. This opening of the trachea is spoken of as tracheotomy.

TRACHEOTOMY

A tracheotomy is an incision into the trachea in order that a tube may be introduced therein, thus providing for the entrance and exit of air. This may be done either as an emergency measure following a thyroid operation in which the trachea has collapsed, when a foreign body has become lodged in the larynx so that respiration is embarrassed, in acute edema of the glottis, or in obstruction asphyxia during the administration of an anesthetic. It may be employed as a preliminary measure to a removal of the larynx for cancer. The operation is either high or low, the high being preferable, because the trachea is more accessible; the low being done when the operator has to reach a foreign body which has fallen into one of the bronchi.

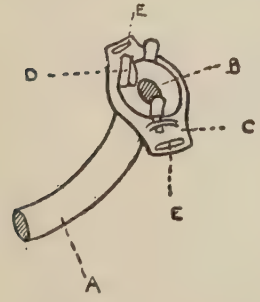


FIG. 24. — TRACHEOTOMY TUBE. *A*, outer tube; *B*, inner removable tube; *C*, safety guard; *D*, catch to hold inner tube in place; *E*, slot through which tape may be tied to hold safety guard in place.

Operation.—The patient is placed upon the back with a sandbag underneath the neck so as to make the trachea as prominent as possible. An incision is made in the midline, the muscles separated, the trachea exposed, incised, and a tracheotomy tube introduced. These tracheotomy tubes are of various types, but the one generally used is similar to Fig. 24 and Fig. 113 B. It is very important, after the tube has been introduced, to see that it is patent, and that respiration is taking place freely. As a precaution, tape is usually threaded through the tube so that it will not slip down the larynx in any disorder which might ensue. Inasmuch as the outer tube comes into direct contact with the

skin, it is a good plan to have a fine layer of gauze covered with boric ointment inserted between the tube and skin.

Post-operative Treatment.—The tracheotomy tube is a new passage through which air is drawn into the lungs, and since the air is no longer brought through the normal channels, it is important that above all the tube should be kept patent and clean. In order to ensure perfect cleanliness and free respiration through the tube, nurses must be on duty day and night ever alert to see that the patient has plenty of air. The inner tube should be removed about two or three times a day, cleansed, sterilized, and gently reinserted. It should never be cleaned in situ, i.e., as it rests in the patient's trachea. If at any time the tube should become suddenly plugged, the inner tube must be withdrawn immediately. At times the patient is apt to cough, and the mucus which makes its appearance at the orifice of the tube should be wiped away very gently. Occasionally from coughing violently both the inner and outer tubes may be expelled, and for this reason it is always important to keep a tracheotomy dilator on hand to meet this important emergency. This instrument will keep this passage open until another tube may be obtained and inserted.

Another important thing in these cases is to remember that the air which is now inspired no longer has the advantage of being warmed and freed from dust by the nasal passages. For this reason, in the beginning thin layers of gauze which have been wrung out in warm water should be placed over the tracheotomy orifice and changed every half hour. Some surgeons keep the patient under a croup tent so that the air may be warmed by steam and the respiratory tract have the advantage of a warmed air. Compound tincture of benzoin may be added to the croup kettles.

There are very few patients who require more conscientious nursing than do these patients, because their lives are absolutely dependent upon the uninterrupted inflow and outflow of air through the tube. They should never be left alone, for one never knows at what moment the tube may become plugged and the patient become suddenly asphyxiated. Occasionally mucus may collect in the trachea and not be expelled through the tube. The reason for this is that the cough is insufficient in strength to expel the mucus plug. In these conditions a steril-

ized feather might be introduced through the tube and the trachea tickled, so as to incite coughing. The time for the permanent removal of the tube is purely at the discretion of the surgeon. Very often some surgeons will remove the double silver tube and replace it by a rubber one, then remove the rubber one when they see fit.

NEW GROWTHS OF THE LARYNX

The larynx, like the other organs in the body, may be the seat of benign or malignant growths. Probably the most common of the benign growths is the papilloma. These growths may be removed in three ways: through the larynx with the aid of the laryngeal mirror; from without by performing a thyrotomy (an incision through the thyroid cartilage of the larynx), or through a Jackson or Killian laryngoscope. The instruments used for their removal may be the snare, curette, forceps or galvanocautery.

Malignant Growths.—The symptoms of a cancer infiltrating the larynx may be very similar to those produced by the benign growths. Hoarseness, later loss of voice, respiratory difficulty, and pain are very common. Later when the growth extends and ulceration becomes evident, cough and pain on swallowing may be very evident. The only treatment is surgical. Either one-half or the entire larynx may be removed.

LARYNGECTOMY

As the name implies the operation is one in which the larynx is excised. The operation itself is preceded by a tracheotomy. This may be done as a preliminary operation one day, the remainder of the operation being performed at another time, or the entire operation may be done at once.

Operation.—The first part of the procedure is practically the same as a tracheotomy except that the trachea is blocked by the use of a Hahn cannula. This is done to prevent the blood from the laryngectomy from leaking down the trachea into the lungs. The cannula is simply a tracheotomy tube which has been previously boiled and to which is attached and securely fastened a sponge squeezed dry and dipped in a ten per cent. ether solution of iodoform. The sponge has been previously sterilized by soaking in a 25 per cent. alcohol solution for several days. The

tube with the sponge is introduced dry. After it is in the trachea from five to ten minutes there is usually enough moisture generated to swell the sponge and block off the larynx above. The technic of the remainder of the operation is unimportant. The Hahn's cannula is taken out after eight hours and the tracheotomy tube introduced.

Post-operative Treatment.—Since the larynx has been removed and the pharynx has just been sutured, it is highly important that the patient be fed for the first few days by rectum, unless a duodenal tube has been introduced through the nose into the esophagus at the time of operation. For the next four to five days feedings should be administered through the nose by catheter, and within a week as a rule, the patient is able to swallow. Of course, in the beginning, only soft diet should be allowed. These patients are very much depressed because of the loss of voice, but they soon learn to whisper and make themselves understood, or they learn to use an "artificial larynx," an instrument which utilizes the expired air from the tracheotomy tube and the lips to reproduce the spoken voice.

INJURIES TO THE THORACIC WALL

Injuries to the thoracic wall may be the result of bullets, stab wounds, or compound fractures of the ribs. The latter occur quite often following severe compressions of the chest, such as occur in "run-over" accidents. Wounds of the chest may be superficial, involving skin and muscle, or deep, penetrating the pleural cavity. The dangers of the last-named variety are the complications of pneumothorax (air in the pleural cavity with collapse of the lung), hemothorax, a condition in which the pleural cavity is filled with blood due to injury of the blood vessels of the lung itself; or, the possibility of a superimposed infection of the pneumothorax (pyopneumothorax).

Treatment of Injuries to the Thoracic Wall.—This is usually surgical in nature. The wound is thoroughly cleansed and the hemorrhage controlled. If any of the ribs have been fractured, they are securely strapped and the patient kept in bed for a few days. Many of these cases, especially those with deep, penetrating wounds, develop serious complications, such as pneumonia, or infection of the pleural cavity (empyema).

EMPYEMA

One of the complications that may occur in chest conditions is empyema, an infection of the pleural cavity. This is usually the result of a pneumonia and rarely occurs as a primary condition.

Symptoms.—The patient gives a previous history of pneumonia, as a rule. After the pneumonia has resolved, or even before this period, a sudden rise in temperature may occur, accompanied by fever, chills, and the physical signs of fluid in the pleural cavity. This collection of fluid or pus may be general in nature, or localized (sacculated). As pus in other parts of the body usually requires drainage as soon as it is formed, here also an attempt should be made to remove it.

X-ray examination of the chest is a great aid both to diagnosis and location of the fluid or pus. This can further be substantiated by an exploratory puncture with a needle inserted in the region of the suspected effusion.

Treatment.—While it was customary before the war to resect a rib and insert a drainage tube into the pleural cavity as soon as a diagnosis of empyema was made, army experience has taught that such radical procedure is not always necessary. In fact, in the beginning, it is better to draw off the fluid which has accumulated with a needle and syringe, or Potain aspirator, thereby relieving the patient and at the same time reducing certain elements which might lessen the shock at the time of the future operation. It is also true that some of the patients recover with this simple aspiratory procedure, although the great majority must have a more radical operation performed sooner or later. The more radical procedure consists of an intercostal incision or in the partial excision of one of the lower ribs so that better and more adequate drainage may be secured.

Operative Treatment.—Inasmuch as these patients are in a weakened physical condition from their pneumonia, or from the absorption of the poisons of the pus in the pleural cavity, it is advisable not to administer a general anesthetic, but to employ local anesthesia. This works with remarkable success.

Since the patients feel more comfortable when sitting almost upright, the operation is performed in this position. An aspirating needle with syringe locates the area of pus; its location is the determining factor as to which intercostal space is to be

incised or which rib is to be partially resected. In general empyema or suppurative pleurisy, the incision is generally made along the eighth or ninth ribs. If a portion of the rib is to be removed (see page 117) a part of the rib is removed subperiosteally, exposing the periosteum beneath which is the outer surface of the pleura. The pleura is then opened by incision and the pus allowed to gradually escape. A drainage tube is then placed into the pleural cavity.

There are many ways of draining the thoracic cavity.

The methods used may be grouped under the "open" or the "closed." The open method consists in an ample incision in an intercostal space with or without a rib resection, and the insertion of one or more drainage tubes. The closed method aims as far as possible to maintain the negative pressure in the thorax so that the lungs may expand earlier, the pleural space become obliterated sooner, and the patient's convalescence be materially shortened. This is accomplished by making a small intercostal incision, inserting a tight-fitting tube into the thorax, and not only fitting the tube carefully to the chest wall so as to prevent the entrance of air, but the free external end of the tube is immediately passed under water so that pus may escape and yet no air may enter the thoracic cavity. In the case of children, to prevent kinking of the tube, the child may be suspended on a net or canvas cover attached to the sides of the crib; a hole is made in the center of the canvas to permit the tube to pass down into the bottle which is kept on the bed itself. This arrangement is known as a *Roth bed.*

Post-operative Treatment.—This depends largely upon which method has been used. If the open method has been employed, the discharge is rather copious for the first few days and the superficial dressing must be changed and reinforced whenever necessary. Some surgeons will remove the original drainage tubes excepting one, after six days, and insert Carrel-Dakin tubes and irrigate the cavity every two hours with Dakin's solution (see Chapter XX). Great care should be taken in using this fluid. If the patient coughs violently, the injection should be stopped immediately, for it may mean that a small opening is present in the lung, communicating with a bronchus, or a *bronchial fistula* is present. When the size of the cavity has been diminished sufficiently, and this can easily be deter-

mined by measuring the amount of fluid that the cavity holds, the injections may be discontinued and simply wet dressings applied. If the Carrel-Dakin technique has not been used, the tubes within the chest are gradually reduced in number and shortened, and as soon as the drainage is very thin and the temperature normal, the tubes may be withdrawn altogether. Even if the closed method of drainage has been used, the cavity may be irrigated and flushed every two hours with Carrel-Dakin solution. When the cavity has contracted to a small size and the drainage is minimum and the temperature has become normal, the tube may then be removed and the case treated similarly to one in which the open method has been employed.

In empyema cases, great care should be taken that the number of drainage tubes used be carefully noted and recorded. The pleural cavity is a notorious hiding place for them, and very often a lost tube is the reason for a persistent sinus continually discharging large quantities of pus.

While the patients are in bed, they should be encouraged to breathe as deeply as possible so as to aid the expansion of the collapsed lung. With this end in view, they should blow fluids from one bottle into another, and children should be given those toys which encourage blowing, such as horns or balloons. If the temperature suddenly rises after the drainage has been removed, it simply means a reaccumulation of fluid in the pleural cavity, and necessitates an immediate reinsertion of the tube.

These patients should be allowed out of bed as soon as possible, and wheeled into the open air. If the weather is clear, their beds might even be moved into the open. The diet should be high in carbohydrates, and tonics should be given to restore their lost strength.

THE LUNGS

The surgery of the lungs is still in its early stages of development, and the operations done upon these essential organs of respiration are but few in number. This is due mainly to shock, to the mechanical difficulty of approach and exposure through the thoracic wall, and because of the difficulty of maintaining the potential negative pressure during an operation. The latter normally exists between the parietal pleura lining the interior of the thoracic wall and the visceral pleura which covers the

lungs themselves. In the various phases of respiration, the parietal and visceral pleurae are continually in contact; but should, for some reason, the air from the outer world enter this space, either by rupture of the lung tissue itself or through the thoracic wall, the negative pressure will be destroyed and the lung will collapse. A large space filled with air will thus be left between the parietal and visceral pleurae. If this is remembered it will not seem strange that pleural and lung conditions take such long periods of time to return to normal after operation, for the infection of this large rigid cavity must be sterilized, the air within the chest absorbed, and the lung permitted to expand with the reëstablishment of the negative pressure.

Methods for Maintaining Negative Pressure.—This may be accomplished by two main methods. The operation may be performed in a special negative pressure chamber. The rooms were designed by Sauerbruch, and are portable. By the other method, the ordinary operating room is converted into a negative pressure chamber, the patient's head being passed through an opening in the wall, so that it is under positive pressure, while the thorax and the rest of the body within the room itself are under the negative. The negative pressure used is from eight to ten millimeters of mercury. Negative pressure methods are rarely used today.

Positive Pressure Method.—This method consists in keeping the lungs expanded by forcing air under pressure into them through the trachea. A catheter is passed through the mouth into the trachea and a stream of warm air under pressure mixed with vaporized ether is forced through by means of a pump. This is successful, and does not require as much time or preparation as the negative pressure methods.

At present, however, this method has been supplanted by administering the anesthesia of gas and oxygen intrapharyngeally through the nose. When it is desirable to inflate the lung the mouth is closed and one of the nostrils is compressed. As a result the lung is expanded by positive pressure.

DISEASES OF THE LUNGS

There are several lung conditions which often respond to surgical therapy, namely inflammatory lesions, extensive bronchiectasis and tuberculosis, and new growths, either benign or

malignant. No special ante-operative preparation is requisite in these cases, but inasmuch as they are poor operative risks, fresh air, transfusions and high caloric diet are indispensable to improve their general condition. It is highly desirable wherever it is feasible to employ either local anesthesia or gas oxygen.

LUNG ABSCESS AND BRONCHIECTASIS

Lung abscess may be caused by aspirating any foreign material, either a foreign body or a piece of tissue, as occasionally occurs during tonsillectomy under general anesthesia, or vomiting while unconscious. Lung suppuration is a distressing condition in which the patient coughs almost incessantly, expectorating huge quantities of foul-smelling pus. Temperature is invariably present and because of the toxemia, the patient undergoes rapid deterioration.

Treatment.—Much can be accomplished for these unfortunate individuals by conservative treatment. They should be given the benefit of open air and sunlight, and their general strength should be augmented by a selected diet, tonics, and transfusions. The abscesses occasionally may be drained by changes in posture; for example, the knee-chest position is often quite effective in evacuating an abscess cavity. Occasionally the patient may bend over the back of a chair and the abscess empty itself.

Suction and irrigation of the abscess cavity through a *bronchoscope* often produces beneficial results. The illuminated metal telescope introduced through the larynx and trachea directly into the bronchi is also of great diagnostic aid in locating the lung pathology, and together with the X-ray, is really indispensable in lung surgery. If the abscess is localized and bronchoscopic treatment is not effective, the lesion must be treated surgically. After the abscess has been localized, either one or more of the overlying ribs are partially resected under local anesthesia. If the underlying lung is freely mobile, the parietal and visceral pleurae must be sutured so that these two membranes will become adherent locally, and thus shut off the remainder of the pleural cavity. This will ordinarily take a few days. However, if adhesions are already present, the second stage may be proceeded with immediately. It consists of localizing the pus with an aspirating needle and then inserting a thermo-cautery through the lung into the abscessed cavity.

This is then drained. These cavities may communicate with one or more bronchi and a tube is kept in place until all the infection has subsided and the sputum is nil. Occasionally, however, an infection is so severe that a *bronchostomy* or external communication of a bronchus with the skin must be maintained for a very long time.

More radical surgery, however, might be indicated if the abscesses are multiple, as frequently happens in a bronchiectasis, a condition in which the bronchi are dilated and filled with pus and the surrounding lung is infected. If the condition is localized to one lobe, then the lobe might be removed; i.e., a *lobectomy* may be indicated. In this operation, the patient is kept under intratracheal anesthesia. A liberal segment of a rib is resected, the pleural cavity opened, and a rib spreader introduced. By turning the lever of the rib spreader, the ribs above and below the resected one are separated sufficiently to gain adequate exposure of the pleural cavity and its contents. The pathological lobe is excised after the vascular pedicle and the bronchi have been ligated. Because of the severe shock connected with this operation, it is usually performed in two stages.

PULMONARY TUBERCULOSIS

The ideal sought in surgical treatment of pulmonary tuberculosis is to rest the affected lung. This may be done (1) by causing a collapse of the diseased lung through creating an artificial pneumo-thorax by introducing purified nitrogen into the pleural cavity with a needle, or (2) by markedly interfering with the action of respiration by paralyzing the intercostal and diaphragm muscles, which aid in expanding the thorax. This will rest the tuberculous lung and may be accomplished by extrapleural thoracoplasty often associated with phrenicotomy.

Extrapleural Thoracoplasty.—This operation usually is performed in two stages, and consists in resecting segments of the first ten true ribs in the para-vertebral line. The segments removed vary from two to four inches. Naturally, this will cause a collapse of the chest, and respirations on that side will be embarrassed materially.

Phrenicotomy.—In order, however, to paralyze the diaphragm, the most important muscle of respiration, it becomes necessary to divide its nerve supply. The phrenic nerve, as it

passes through the neck, is cut or avulsed, causing a paralysis of the diaphragm on that side. This procedure is known as phrenicotomy. Through extra-pleural thoracoplasty, and phrenicotomy, the lung is rendered almost immobile and the increased circulation plus the rest may aid in conquering the tuberculous infection. After operation, the affected side should be further immobilized with a brace, and the patient given the benefit of climatic change suitable for this type of infection.

Tumors of the Lung.—These may be cysts or carcinoma. Simple cysts are localized tumors which may be removed alone, or with the lobe in which they originate. If the cysts are too large for excision, they may be opened and emptied, and the walls sutured to the skin of the chest (marsupialization), so that the fluid will not accumulate again.

Carcinoma of the lung or pleura is rarely operable. Although the progress in these cases is rapidly fatal, they should be given the benefit of radiotherapy.

Foreign Bodies in the Lungs.—Very often foreign bodies become lodged in the lungs, if they pass the trachea and bronchi without being obstructed, they may be localized by means of the X-ray if the body is opaque, or with the bronchoscope. Quite often they may be removed through these instruments or, in very rare instances, the lung may be incised to remove the foreign bodies.

CHAPTER VII

THE SURGERY AND SURGICAL NURSING OF THE GLANDULAR SYSTEM

In no other system within recent years has the advance been greater and the research more extensive than in the field of the glands of internal secretion. It is true that we still know very little concerning most of them. But possibly within the next decade or so there will be great light shed upon the physiology of those organs which either alone or in combination control our physical and mental make-up. Glandular tissue has been described as that tissue which has for its function the secretion of certain substances. These may be of service to the body, as the digestive juices, or they may be purely excremental in nature, removing substances which are either poisonous or waste in character.

CLASSIFICATION OF GLANDS

It is convenient to divide glands into three groups: (1) those with ducts, (2) those without ducts (the glands of internal secretion), and (3) those which are a combination of (1) and (2). As examples of glands with a duct there may be mentioned the liver, the largest gland in the body, which secretes and excretes bile through the biliary duct; the submaxillary glands, the mammary glands, the prostate, sebaceous, sudoriferous, etc. Pure glands of internal secretion may be represented by the pineal, the pituitary, the thyroid, the parathyroid, and adrenal. Those glands which are both external and internal in secretion are represented by the pancreas, the ovary and the testis.

While the surgery of these glands is limited, probably those deserving most of our attention are the liver and the bile ducts which have been discussed under the gastrointestinal tract, Chapter V, the ovary and testis which are reviewed in Chapter VIII on the reproductive system, leaving for discussion here the pituitary and the thyroid and the lymph glands.

DISEASES OF THE PITUITARY GLAND

The pituitary gland is composed of an anterior and a posterior lobe. It arises from the forebrain and rests in the sella turcica of the sphenoid bone. The function of the pituitary gland is probably concerned with growth. Too much secretion or hyperpituitarism is a condition which, if it occurs before the ossification of the epiphyses, leads to gigantism, and, when it occurs later, after the bones have become full-grown, is responsible for acromegaly. Too little secretion of the pituitary body (hypopituitarism) in a growing child leads to increased fat deposition in the tissues, dwarfism, and poor development of the sexual organs. When this occurs in the adult it leads to adiposity and sexual retrogression.

Probably the cases which interest us most from the surgical standpoint are those in which the pituitary gland is enlarged, with the result that the patient complains of bitter headaches, and a beginning blindness. This is often seen in the late stages of acromegaly, a condition in which there is a progressive increase in the size of the hands, feet, head, jaw, and the tissues about the face.

Treatment.—Surgery endeavors to remove part of the pituitary gland. This may be done either by removing part of the body of the sphenoid bone via the nasal route, or by the subtemporal path. There is no special nursing entailed.

DISEASES OF THE THYROID GLAND

The word goitre is familiar to the lay mind, and even a layman distinguishes two types,—the one in which there is simply an enlargement of the thyroid gland, and the other in which there is enlargement complicated by definite nervous symptoms. Just as in the pituitary, there may be an increase or perversion of the thyroid secretion, known as hyperthyroidism, or there may be also a diminished secretion. If it occurs before the age of puberty, or dates from birth, cretinism results, or if it occurs in adult life, myxedema may occur.

Cretinism.—These children have a diminished thyroid secretion. As a rule they are fat and pudgy with coarse, sparse hair, unable to walk, and have a subnormal temperature; their mentality is practically nil. Thyroid extract given to these unfortunates often transforms them at least from an animal

stage to a point where they can protect themselves sufficiently to exist.

Myxedema.—Very often patients in adult life begin to show signs of mental sluggishness with a slow reaction time, and their faces become coarse and mask-like. The basal metabolism is low. In other words, they are somewhat like cretins. Thyroid extract or any preparation of the thyroid gland, given by mouth, helps these people markedly.

GOITRE

Any enlargement of the thyroid gland that is chronic in nature is spoken of as a goitre (see Fig. 25). There are certain regions of the earth where this disease is common; it is frequently seen in some mountainous places of Germany, Austria, France, Central Asia, Switzerland, and around the Great Lakes in Michigan. It is thought to be due to a deficiency of iodine in the drinking water of these districts. The symptoms which come from the goitre are mechanical, and result from pressure of the enlarged gland upon those structures which it might compress. From pressing on the wind pipe (trachea) it may give rise to a cough, stridor or dyspnea, or it may cause difficulty in swallowing, by pressure on the gullet (esophagus).

Treatment of Goitre.—Goitre may be treated medically or surgically. Some cases respond to the internal administration of potassium iodide, iodine or Lugol's solution. X-ray, when given in graduated doses, sometimes reduces the size of the gland. But if the goitre is large and the symptoms are aggravating and persistent, surgery is practically the only measure which will afford relief.

Ante-operative Treatment.—On the morning of operation the neck should be shaven, cleansed with green soap and water, followed by alcohol and ether, and a sterile dressing applied.

Operation.—Gas and oxygen is the anesthetic of choice. The patient is placed upon the back with a sandbag beneath the shoulders so as to put the neck upon a slight stretch (see Fig. 102, page 347). In addition to the ordinary "set-up" of instruments, in all operations upon the thyroid, it is essential to have a tracheotomy outfit in readiness. For very often in these operations, because of pressure on it, the trachea collapses, and unless instant measures are instituted to relieve the strangu-

lation due to the closure of the trachea, death will readily ensue because of asphyxiation. This horrible complication fortunately is rare, but adequate preparation must always be made to meet any emergency. Inasmuch as a few seconds will mean the life or the death of a patient, everything should always be in readiness for even this rarest of operative complications.

FIG. 25.—COLLOID GOITRE.

As there is bound to be a moderate amount of bleeding and oozing from the tissues, a small cigarette drain is employed for about 24 hours, and the ordinary sterile dressing is applied. Since the line of incision in a goitre operation is quite visible in the modern female, attempts are made to minimize the scar as much as possible. To ensure perfect healing after operation

the neck is usually immobilized by means of starch bandages; these form a very light and efficient means of restraining the grosser motions of the neck.

Post-operative Care.—The patient should not be permitted to talk any more than is necessary for at least a week. Attention should be paid to the character and tone of the voice. The reason for this is obvious, when it is recalled that the nerves which partially control the vocal cords lie close to the gland and may have been injured or cut during the operation. This is indeed a serious complication, because if they are cut it will result in permanent alteration of the patient's voice.

It should also be remembered that occasionally patients run a high temperature, rapid pulse, and may even be delirious. The syndrome is often spoken of as acute thyroidism. This condition should be treated with ice packs, but this will be discussed at greater length in the treatment of exophthalmic goitre.

EXOPHTHALMIC GOITRE

As a splendid example of what attention to all details in an operation will do, nothing is more striking than the reduction in the mortality of exophthalmic goitre from sixteen per cent. to practically one per cent. This has been made possible by the energetic researches of Dr. George Crile. The factors which have caused this tremendous drop have been the use of gas and oxygen as an anesthetic, local anesthesia, multiple stage operation, coping with the mental attitude, bringing the operation to the patient, and the employment of the ice pack in cases of acute thyroidism.

Symptoms.—Patients with exophthalmic goitre as a rule are recognized immediately by the fact that their eyes are prominent and protrude, and that they are extremely nervous. Their pulse rates vary from 90 to 120, and sometimes even higher. In other words, they have what is called tachycardia. Their skin as a rule is moist, and they perspire freely. A very definite swelling of the thyroid gland is often visible. Their basal metabolic rates are elevated far above the normal. These symptoms all point to a poisoning from either an increased amount, or a perversion of the thyroid secretion. It does not take much imagination to realize that, above all else, these patients need peace and quiet. They are nervous to the extreme. Association

with others, incessant talking, and noises tend greatly to aggravate them and increase their pulse rates. The keynote in the care of these patients is rest under ideal surroundings and treatment administered so tactfully and carefully that the shock to the nervous system will be of the minimum.

Treatment.—Medical.—All cases of exophthalmic goitre should, as a rule, be treated medically at first. The treatment consists of rest in bed, complete isolation from society, a diet of high caloric value with forced feeding, and the administration of sodium bromide to relieve the intense nervous excitement. Some physicians give iodine internally, and some use thyroid extract. Detailed accounts of the medical nursing in these cases may be found elsewhere.

Surgical.—It is in the surgical treatment of hyperthyroidism that tremendous strides have been made. The patient at present is not operated upon the day after she enters the hospital. These highly nervous women are no longer subjected to the terror of being ridden directly to the operating room and arriving there with a pulse of 140; then, in their weakened condition, subjected to ether anesthesia and a shocking operation, with the result that, having little stamina left, they usually succumb within twenty-four hours after a partial thyroidectomy has been attempted.

Ante-operative Treatment.—In the treatment of these cases it cannot be emphasized too strongly that great tact and care should be utilized by the nurse in charge so as to gain the absolute confidence of the patient. The room which the patient is to occupy should be bright, well ventilated and airy, away from all noise such as street cars and busy corridors. The patient should be kept continually in bed, not even being allowed lavatory privileges. The diet should be plentiful, an accurate account kept of the food ingested, and the caloric value figured accurately, because it is imperative that these cases be given 5,000 calories or more of food a day. The patient should be kept quiet on liberal dosage of bromides, even to the point of bromidism. Visitors should be few, and their period of stay limited. All depressing topics of conversation must be barred. Anything which would arouse the excitement of the patient, such as dazzling headlines in the current newspapers, melodramatic stories, and trashy magazines, must not be permitted.

Since the slamming of windows and doors always causes a sudden shock to the patient, great care should be taken to see that it does not occur. In other words, the medium in which the patient lives must be calm, serene and peaceful. Lugol's solution should be administered three times daily for about ten days. It is amazing to see how this medication not only reduces the pulse rate but materially lowers the basal metabolism.

As soon as the patient has sufficiently recuperated from the strangeness of hospital surroundings, and the pulse rate has fallen around 90, and the basal metabolism has been lowered, it is advisable to acquaint the patient with the fact that she is to prepare for operation. The anesthetist who is to give the anesthesia should be introduced; he should explain the operation of the gas mask, place it gently over the patient's head, teach her how to breathe through it, and just what she is expected to do. He should visit her daily and rehearse the little act of psychologically anesthetizing the patient. In the meanwhile the nurse should prepare the neck as if the operation were really to be performed. The anesthetization of the patient when possible should be done in her private room, and as the patient has become accustomed to the anesthetist, the mask and the preparation of the neck by the nurse, it is possible that the actual day of operation may be kept secret from the patient. In other words, the gland may be stolen away, the patient little knowing that one of the rehearsals with the anesthetist is part of the actual operation.

The anesthetic which is used is nitrous oxide and oxygen, and, in addition, the line of incision is usually first injected with novocain, ½ per cent. The operation was formerly performed in stages; that is, the blood supply to the thyroid was first lessened by the ligation of the superior thyroid arteries, and then the inferior thyroid arteries. This was done under local anesthesia, or under gas and oxygen. The reason for the preliminary ligation was to diminish the blood supply of the thyroid. This simple procedure in some rare cases was all that was necessary, and with it the symptoms of hyperthyroidism abated and the patient needed no further surgical treatment. If, moreover, the symptoms were not definitely improved, at least the blood supply of the gland was lessened, so that when the thyroid was removed, the hemorrhage was materially decreased, the

degree of shock was less, and a speedy recovery of the patient was assured.

At present, however, by the use of Lugol's solution in the ante-operative preparation, a single operation, that of subtotal thyroidectomy, is performed. In this procedure about seven-eighths of the thyroid gland is removed, leaving only the posterior surfaces of the original gland. It has been found that to really effect a permanent surgical cure, a radical subtotal thyroidectomy must be performed. Anything short of this operation is simply a temporizing procedure eventually yielding a very unsatisfactory result.

Post-operative Treatment.—The patient should be kept especially quiet with morphine and given plenty of fluid by rectum. Very often these patients are subject to a sudden rise in temperature, sometimes as high as 106 degrees, and an increase in pulse rate that is rapid and thready. Their faces become pinched and covered with perspiration; they are apt to become delirious and die within a very short time. These symptoms are thought to be due to an acute hyperthyroidism. It has been found that as soon as these symptoms occur, they may be controlled by the use of the ice pack.

Occasionally, following the operation there may be a hemorrhage from the operative wound. The bandage should be reinforced and the operating surgeon immediately summoned. More rarely a condition of edema of the glottis may develop. This is evidenced by difficulty in breathing, cyanosis of the patient, and a bubbling respiration. This condition demands immediate attention, often tracheotomy (Chapter VI, page 113), and no time should be lost in summoning the medical officer in charge.

Following any operation upon the thyroid, especially of exophthalmic variety, the patient should be given a prolonged rest in some quiet mountainous resort. The surroundings should be congenial, and the patient should not be permitted to return to her usual environment until the attending physician feels assured that she can stand the strain.

TETANY

Occasionally after rather an extensive removal of the thyroid gland, a peculiar condition may result, namely that of tetany. This is presumably due to the fact that the parathyroid glands

which are closely attached to the posterior surface of the thyroid have been partially removed.

The symptoms of tetany are intermittent, bilateral spasms confined to the extremities. These paroxysmal attacks may be controlled by the administration of calcium lactate, about fifteen grains every three hours, and by the intravenous administration of parathyroid extract.

THYROGLOSSAL CYSTS

These are small congenital tumors occurring in the mid-line of the neck in the region of the hyoid, and are embryological remnants of thyroid development. These may become secondarily infected, break down and form a fistula which constantly discharges. The treatment is surgical, and inasmuch as the fistula often runs through the hyoid bone, and up towards the base of the tongue, it may be necessary to remove a medial segment of the hyoid bone. This, however, rarely causes the patient any permanent inconvenience.

LYMPH GLANDS

These glands are involved in acute and chronic inflammations and by new growths.

Acute Lymphadenitis.—The lymph glands are usually involved secondarily to some primary focus; for example, in cases of hand infection, the axillary nodes are often tender. If they become enlarged, red and tender, they should be treated conservatively either with ice packs or poultices. If the condition does not subside, and the glands break down, incision and drainage are indicated.

Chronic Lymphadenitis.—One of the most common forms of lymph gland involvement is that due to tuberculosis, especially of the glands of the neck. X-ray treatment and exposure to the actinic rays of the sun often produce remarkable retrogression in the size of these nodes, but if they show a tendency to suppurate, radical removal is essential. There are no special nursing problems involved.

New Growths of Glandular Tissue.—These are either primary as Hodgkin's disease, or lymphosarcoma, or secondary to primary carcinoma or sarcoma elsewhere. If the glands are primarily involved, they should be radically excised; if secondarily

involved, provided they are in juxtaposition to the area of primary carcinoma, they should be removed by block dissection. For example, in carcinoma of the breast, the glands in the axilla should be removed, and in a carcinoma of the tongue, the glands in the submaxillary region and in the neck should be taken out. But if the glands in the neck are involved secondary to a carcinoma of the stomach, surgery has no place. If it is deemed inadvisable to remove the glands, the patient should be given the benefit of radium and X-ray treatment.

CHAPTER VIII

THE SURGERY AND SURGICAL NURSING OF THE REPRODUCTIVE SYSTEM

COMPOSITION

The genital systems of the female and male may be divided into the external and internal organs of generation. The external organs in the female consist of the mons veneris, the external opening of the urethra, the clitoris, the labia majora, labia minora, and the hymen; the internal organs are the vagina, the uterus, the tubes and ovaries. In the male, the external organs of generation are the penis, the scrotum which contains the testis, the epididymis, part of the vas deferens; the internal, the prostate and the seminal vesicles.

OPERATIONS ON FEMALE GENITAL SYSTEM

The operations on the female genital system resolve themselves into two classes, those which are external, and those which are internal. The external, mainly plastic operations, are those done for the relief of a relaxed perineum or lacerated cervix, injuries which follow tears incident to childbirth. A weakened pelvic floor may result in a relaxation of the anterior vaginal wall with a subsequent prolapse of the bladder (cystocele). If the posterior wall of the vagina is weakened, a prolapse of the rectum may occur (rectocele). Surgery attempts to correct the cystocele and rectocele by operations upon the vagina and a reconstruction of the muscles of the perineum. These operations come under the general head of perineorrhaphy.

PERINEORRHAPHY

The ante-operative procedure: The vulva should be shaved, scrubbed with green soap and water, then with alcohol and ether. It is advisable to catheterize the bladder routinely in all these cases. The patient is placed in a lithotomy position (see Fig. 89, page 336) and the various operations for the relief of

the pathological conditions are performed. The technic of the operation does not concern us here.

Post-operative Care.—Most institutions and hospitals have standard perineorrhaphy routines. The various methods are herewith outlined:

The routine which the nurse will follow in the after care of a perineorrhaphy will always be prescribed by the surgeon; it will vary considerably from time to time, depending upon the extent of the wound and the preferences of the particular surgeon. In any case it is extremely important to keep the wound surgically clean. At best, the task is not easy, nor very satisfactory because of the necessary, frequent exposure to the unsterile excretions of the body. Fortunately, however, nature has provided this part of the body with unusual resistance to infection, and therefore consistent and conscientious technic in the treatment of a perineorrhaphy wound will be rewarded with good results. Some surgeons will require that the part be kept immobilized for at least the first forty-eight hours. This is accomplished by means of a bandage passed about the thighs binding the legs together. This will be particularly desirable in the case of a restless patient. Other surgeons, however, will not prescribe this treatment and the nurse will, of course, not administer it as a routine practice because it is a rather trying ordeal for some patients. When applying this bandage the nurse should remember the rule forbidding the bandaging together of any two surfaces of skin and should see that the thighs are comfortably separated by means of a layer of non-absorbent cotton.

Sometimes catheterization will be prescribed to avoid contamination of the wound by the urine. This may be for only a period of forty-eight hours at stated intervals, or it may be for a longer time. In some cases treatment will be directed toward preventing evacuation of the bowels for a stated period, sometimes as long as nine days, particularly if the laceration has been a complete one—that is, one which has extended into the rectum. This treatment will consist of opium medication to suppress peristalsis, of fluid diet without milk, or of the two combined. Often, however, especially in cases of the slighter wounds, catharsis, oil enemas, etc., will be given in the course of a few days. Whatever the prescribed general treatment, however, the nurse must follow rigid aseptic technic throughout.

Catheterization, of course, is always done with the most thorough asepsis, so no special lesson will be necessary here as to that, except to point out that in this case the asepsis must be in the interest of the wound as well as the bladder. As a rule, whether or not catheterization is done, after the bladder has been emptied the perineum will be douched with sterile water or some mild antiseptic solution such as 2 per cent. boric acid or 1-5000 bichloride, which will be allowed to flow over the wound from a pitcher or irrigator. The wound is then carefully patted dry with sterile gauze and the prescribed dressing applied. Sometimes the dressing will be only the plain dry gauze; but a dusting powder, such as aristol, or an ointment, such as boric acid, may also be applied. Keeping the wound dry is an important part of the nurse's duty in this case and it will require careful manipulation on her part because perineorrhaphy sutures are very frequently of silkworm gut, which will mean that they will be likely to catch upon dressings and involve the risk of tearing the wound and also of causing considerable pain to the patient. The aseptic precautions will be necessary at least until after the sutures have been removed, which may be any period of from five to ten days.

THE UTERUS

The uterus is a muscular, pear-shaped organ situated in the pelvic cavity between the bladder and the rectum. Its normal position is that of anteversion. The part of the uterus which projects into the cavity of the vagina is known as the cervix. The uterus is lined with mucous membrane; and entering the fundus or body of the uterus are the openings of the Fallopian tubes. The uterus may be the seat of acute inflammations, malpositions, or new growths, either benign or malignant.

INFLAMMATIONS OF THE UTERUS

The mucous membrane of the cervix of the uterus may become acutely inflamed due to a variety of causes, especially from an infection by the gonococcus. This condition is known as endocervicitis, and if the inflammation extends further and attacks the mucous lining of the uterus, the process is known as endometritis. The treatment of this condition may be either medical or surgical.

Treatment of Acute Inflammatory Conditions.—In the acute infections, especially those due to a gonorrhea in which there is an associated urethritis (inflammation of the urethra) and a purulent vaginal discharge, it is of the greatest importance to warn the patient of the severe infectiousness and contagiousness of the disease, and the dire results which follow, if it is willfully neglected. It is imperative that the hands be kept away from the eyes, because a gonorrheal infection of the organs of sight may cause total and permanent blindness.

The patient should be placed in bed, and upon individual precautions, given a bland non-irritating diet without condiments or spices, and all alcoholic beverages absolutely forbidden. Fluids should be forced to the utmost, and the attending nurse should give copious vaginal douches every four hours with any silver preparation, either protargol or argyrol, in dilutions of 1-10,000. In more chronic stages, these may be followed by silver nitrate irrigations.

THE CERVIX

The cervix, as a rule, is treated by the surgeon by direct applications of 10 to 20 per cent. silver nitrate, iodine, or 20 per cent. argyrol. The patient is appropriately draped, placed in the lithotomy position, a bivalve speculum is introduced, and the applications made directly to the cervix. However, in all these treatments, while the cervix itself may be benefited, it is difficult to reach the endometrium or lining mucous membrane of the uterus, and very often more radical surgical procedures have to be resorted to when the condition becomes chronic.

Operative Treatment.—One of the most common procedures is the operation known as dilatation of the cervix and curettage of the uterus. The purpose of the dilatation is to insure sufficient stretching of the cervical canal, so that instruments may be freely passed into the uterus, and secondly to insure drainage of the uterine cavity. The object of the curettage is to scrape away the diseased mucous membrane of the uterus so that a new and healthy lining will replace the diseased part. While this operation is done for chronic inflammations, it is also performed for the retained membranes of pregnancy, and for incomplete abortions. It is also a diagnostic measure, for in doubtful cases

of cancer of the uterus, the curettings may be examined for microscopic evidences of malignancy.

There are cases in which there is a definite stenosis, or narrowing of the cervix, resulting in very painful menstruation (dysmenorrhea) and often in sterility. In order to insure a permanent opening of the cervical canal, after operative dilatation, a stem-pessary of either glass or rubber is often sewed in the cervical canal, and permitted to remain in place until the appearance of the next period. While the stem-pessary is within the cervix, a daily douche of disinfectant variety should be administered, as the mechanical presence of the foreign body generates a certain amount of disagreeable discharge.

When the cervix is badly torn, the laceration may become a source of irritation. A plastic repair is often done, the operation being known as trachelorrhaphy. When the tears are multiple or there is a marked chronic endocervitis it may be necessary to amputate the cervix partially or completely.

MALPOSITIONS OF THE UTERUS

While the normal position is that of anteversion, the uterus may occupy a backward position. This is spoken of as retroversion. Naturally there are many women with a retroversion of the uterus without symptoms, but if backache and other reflex symptoms are severe, the uterus must be replaced. The replacement will be dependent upon the movability of the uterus. The uterus may be replaced sometimes by manual manipulations by the surgeon with the patient in the knee-chest position. Should the procedure prove too painful, because of inflammatory products binding the uterus to other structures, hot vaginal douches may be ordered twice daily, after which the patient is instructed to assume the knee-chest position for periods of from five to ten minutes, night and morning. The insertion of medicated cotton tampons into the vagina is often quite effective. This often diminishes the inflammation to such a degree that manipulations on the part of the doctor are less painful and more successful. After the uterus has been replaced it may be held in position by pessaries. These are appliances, usually of hard rubber, of various forms, which are introduced into the vagina with the object of exerting pressure so as to hold the uterus in place. Pessaries must never be sterilized by boiling because, if they are

made of rubber, boiling alters their shape. If the uterus cannot be brought back by these measures, operative procedures must be resorted to.

Operations for Retroversion.—The purpose of all operative procedure is to bring the uterus forward and upward to its normal anatomical position and to hold it securely there. In the majority of operations this is accomplished by shortening the round ligaments. The operation may be performed through the inguinal canals, through the abdomen, and through the vagina.

The inguinal canal route:—As the round ligaments help to maintain the normal position of anteversion, they may be isolated in the inguinal canal, drawn out and sufficiently shortened so as to exert tension, and thus mechanically pull the uterus forward into place.

The abdominal route:—The uterus is lifted from its retroverted position and the fundus is sutured to the anterior abdominal wall directly (ventral fixation). Or the round ligaments are sutured to the recti muscles (the so-called Gilliam operation of ventral suspension), or behind the uterus.

The vaginal route:—The patient is placed in a lithotomy position, and the operation done through the vagina. The uterus is brought forward by suturing it either to the anterior vaginal wall, or the lower part of the bladder, or it is pulled into place by shortening the round ligaments.

PROLAPSE OF THE UTERUS

This condition is often called "falling of the womb." Prolapse of the uterus is divided into three degrees. The first degree is that in which there is a relaxation of the pelvic floor with a protrusion of the vaginal walls; in the second degree, the cervix is found at the vulva; and in the third degree there is a mass of the uterus protruding from the vagina and lying between the thighs.

Treatment of Prolapse.—The palliative measures are the use of pessaries and tampons. A large circular rubber ring in the vagina is often very efficacious in maintaining the uterus in position. It is highly important that these pessaries be removed at least once a month and cleaned, and at the same time the vaginal canal be inspected to determine whether any irritation is present.

The curative measure is operation. The uterus is brought forward and upward by a ventral fixation and a perineorrhaphy gives support below. In some cases it is often advisable to remove the uterus (hysterectomy).

TUMORS OF THE UTERUS

The uterus may give origin to benign and malignant growths. The most common benign tumor is a fibroid. (Fig. 26.) These may cause bleeding (menorrhagia), vaginal discharge, pain, and

FIG. 26.—MULTIPLE FIBROIDS OF THE UTERUS. (Courtesy of Dr. Edward D. Truesdell.)

quite often a mass may be felt within the abdomen. However, there are many women who have fibroids which never cause symptoms. Fibroids are treated by X-ray, radium, and operation.

Operative Treatment.—If the fibroids are single and do not involve the entire uterus, the tumor may be enucleated (myomectomy). If the tumors are multiple and involve most of the uterus, the entire organ may be removed (hysterectomy). This is an operation designed to remove the uterus. It may be

performed through the abdomen (supravaginal hysterectomy), or it may be done through the vagina (vaginal hysterectomy).

Supravaginal Hysterectomy.—After the patient is anesthetized, she is placed in an exaggerated Trendelenburg position. (Fig. 80, page 329.) The abdomen is opened by a median incision and the intestines are carefully padded off with warm, moist saline pads. The fundus of the uterus is seized with a vulsellum. The broad ligaments on each side are clamped, and, if possible, one of the ovaries is left. The uterovesical fold of the peritoneum is incised and dissected toward the bladder. The uterine arteries are then clamped and the uterus is amputated through the cervix. The cervical stump is grasped with a second vulsellum, and the cervical canal is cauterized with carbolic acid or iodine. The cervix is then united with interrupted sutures, and the vessels usually tied with plain gut. The round ligaments are sutured to the cervical stump and the pelvic peritoneum approximated to the pelvic peritoneum. This, of course, leaves a little cervical tissue which may cause a persistent leukorrhea. To avoid this the entire cervix may be extirpated.

When the pelvic operation has been completed, the patient should be returned to the horizontal position and the abdominal wall closed. Occasionally vaginal drainage is required. This is done before the abdomen is closed by passing a curved clamp into the vagina and pressing against the posterior vaginal wall behind the cervix. The surgeon incises this area and introduces a cigarette drain into the clamp. When this is withdrawn, the drain is pulled down into the vagina.

There is no special nursing required post-operatively except that a careful watch should be kept for hemorrhage. Occasionally, although fortunately rarely, a ligature slips, and an uterine artery will start to bleed. This requires immediate surgical interference. Patients, as a rule, are kept in bed for about sixteen days.

Vaginal Hysterectomy.—This is performed through the vagina without an abdominal incision. It has no advantage over the other except that it does not leave a scar.

MALIGNANT DISEASES OF THE UTERUS

These may affect either the cervix or the body of the uterus. They are usually carcinomatous in character. The treatment is

either complete hysterectomy (Fig. 27) or the application of radium.

DISEASES OF FALLOPIAN TUBES

Any inflammation of the Fallopian tubes is spoken of as salpingitis. It may be acute or chronic.

ACUTE SALPINGITIS

This may be due to an infection occurring during labor, from unclean instruments, much instrumentation, or a preëxisting gonorrheal infection. The history usually given is that of a vaginal

FIG. 27.—CARCINOMA OF THE CERVIX OF THE UTERUS FOR WHICH A PANHYSTERECTOMY WAS PERFORMED. (Courtesy of Dr. Walton Martin.)

discharge, abdominal pain of a colicky nature and, in addition, the history of a recent labor, instrumentation, or gonorrhea.

Treatment.—The treatment consists of absolute rest in bed in the Fowler position (Chapter V, page 90). Hot vaginal douches are given every six to twelve hours depending upon the severity of the inflammation. Applications are made to the lower abdomen, either in the form of heat or cold, and movements of the bowels should be assured by enemas. If the pain is very severe, sedatives may be given. Very often these cases of tubal infection are complicated by pelvic peritonitis resulting in the development of a pelvic abscess. Instead of draining this

through the abdomen, the abscess may often be drained through the vagina by making an incision between the posterior part of the cervix and the posterior wall of the vagina. This is known as a *colpotomy*. A good sized drainage tube is introduced into the abscess cavity, but because of the dependent position, the drainage tube will not stay in place without some special arrangement of a cross piece, so as to make a "T" tube. Great care should be taken that the vagina is kept scrupulously clean, and the drainage free. To accomplish this, vaginal irrigations with normal saline solution should be given twice a day.

CHRONIC SALPINGITIS

This may be a sequel of acute salpingitis. The tube may either be bound down with fibrous adhesions, or it may be dilated and filled with watery material (hydrosalpinx); or it may be filled with pus (pyosalpinx). Occasionally it may be tuberculous.

Symptoms and Treatment.—The symptoms are backache, pain in the lower abdomen, menstrual disturbances, weakness, and vaginal discharge. Physical examination may reveal a mass in the pelvis. If the case is adjudged favorable for operation, a low laparotomy is performed with the excision of the affected tube (salpingectomy). There are no special ante-operative or post-operative measures other than those which have been outlined in all other abdominal operations.

ECTOPIC PREGNANCY

The ovum is normally fertilized in the tube, and it continues its journey until it reaches the uterine cavity, where it becomes implanted and proceeds to develop. Occasionally, however, the fertilized ovum becomes arrested in the tube and begins its development in this location. This is spoken of as an ectopic gestation. The degree to which the tube may increase in diameter because of the growing ovum is limited. The result is that it ruptures, causing the death of the embryo and hemorrhage from the tube. (Fig. 28.) This bleeding is a source of great danger to the mother because it may result in death.

Symptoms.—The history, as a rule, is that of delayed menstruation. The patient is seen generally after the tubal rupture. This gives rise to sharp pains localized in the lower abdomen,

and fainting spells due to the loss of blood. If the hemorrhage is marked, the patient will exhibit all its characteristic signs.

Treatment.—Immediate operation is indicated, for the bleeding from the tube must be stopped by salpingectomy, and the tubal branch of the ovarian artery ligated. The free blood in the pelvis is removed by sponging or aspiration.

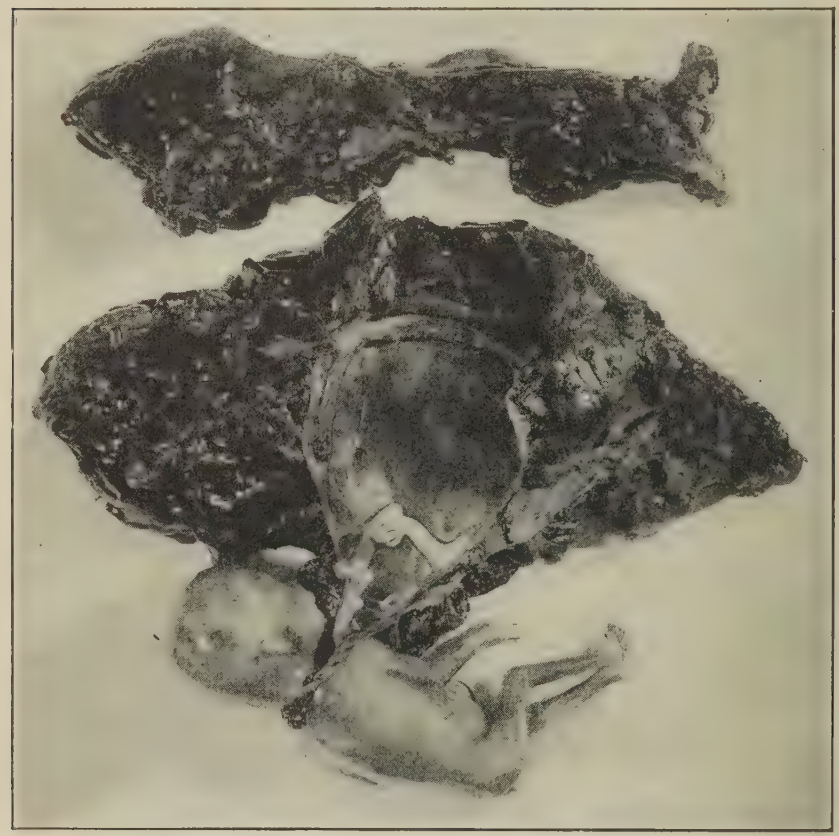


Fig. 28.—Ruptured Ectopic Gestation, Showing Ruptured Fallopian Tubes Containing Fetus and Blood Clot. (Courtesy of Dr. Edward D. Truesdell.)

Post-operative Care.—As these patients are suffering, as a rule, from loss of fluid, saline is given intravenously, and, as soon as possible, a blood transfusion. They are kept warm like other shocked patients, but if it can be avoided, the shock position is not used. As soon as they have recovered sufficiently they are placed in the Fowler position. Means are taken, as soon as

practical, to increase their red blood cells by the use of tonics, and the administration of iron in the form of Blaud's pills.

THE OVARY

The ovary besides secreting the ovum possesses an internal secretion which exercises a very important part in maintaining the normal nervous balance of the individual. Removal of both ovaries results in the complete cessation of menstruation and a train of nervous symptoms which make these patients objects of pity. They become very excitable, nervous, melancholy, and often so desperate that they have ended their existence by suicide. It is now the custom, whenever possible, to leave some part of the ovarian tissue, and should it be absolutely necessary to remove all of it, as in radical panhysterectomies for cancer of the uterus, the patient may be fed the ovarian extract of an animal. It is surprising what good results will follow.

DISEASES OF THE OVARY

Ovaritis is an inflammation of the ovary, rarely primarily diseased but usually secondary to tubal inflammation, which results in adhesions between both structures producing a condition spoken of as "diseased adnexa" or salpingo-oöphoritis. The symptoms are similar to those of salpingitis and the treatment employed is the same.

New Growths.—Cysts.—More than any other organ, the ovary is apt to give rise to cysts and cystic degeneration. The cysts may be of small size, or grow to enormous dimensions weighing more than twenty pounds. (Fig. 29.) They may be filled with a clear viscid fluid or with other cellular materials. Types of the last-named variety are occasionally called cystadenomas. Certain of these tumors, if their contents are spilled over the peritoneal cavity, will cause secondary tumors acting much like malignant growths.

Some cysts may contain remnants of the epidermis, such as hair; in addition bone is often found as well as other tissues; these are known as dermoids.

Carcinoma.—The ovary may be the seat of carcinomatous tissue and cancers of the ovary are frequently extremely malignant, metastasizing early.

Treatment of New Growths of the Ovary.—In the case of simple cysts, only part of the ovary affected may have to be removed, or if the entire ovary is filled with many small cysts, a complete oöphorectomy may be performed. It is highly important that cysts of the ovary be delivered intact. Every effort should be made to preserve their integrity, for occasionally a cyst may be of the adenomatous variety, and if accidentally

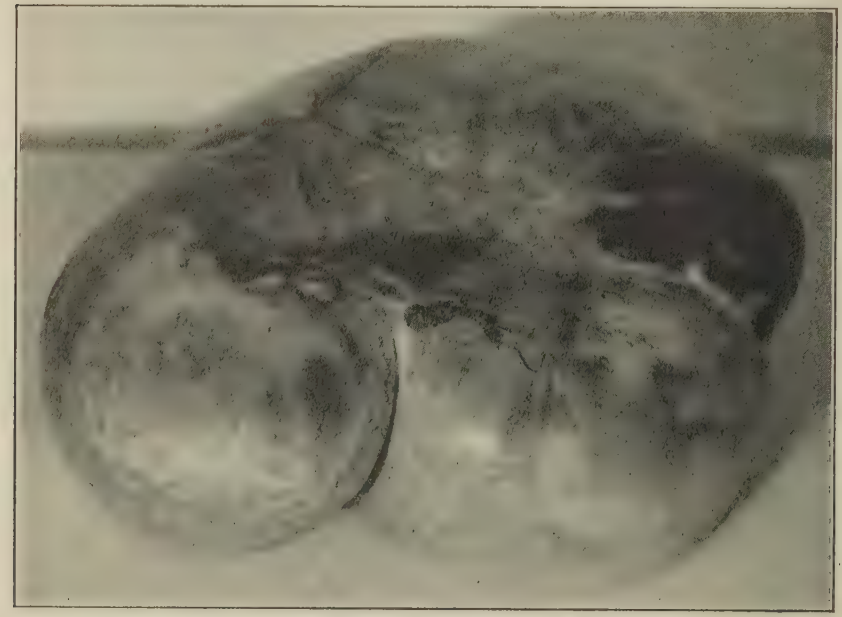


FIG. 29.—SIMPLE CYST OF THE OVARY. (Courtesy of Dr. Richard W. Bolling.)

ruptured, the fluid escapes into the general peritoneal cavity and implantation growths take root.

In carcinoma of the ovary, the treatment, of course, is extirpation with subsequent X-ray or radium treatment. The general outlook of patients with ovarian carcinoma is indeed poor.

THE TESTICLE

This is the male organ of generation and corresponds to the ovary. It consists of the testes proper, which manufacture the spermatozoa, and the epididymis which is really a series of canals collecting the sperm from the glandular substance of the testes. These tubules, or canals, unite to form a single duct, the vas deferens, which carries the testicular product to the seminal

vesicles, small pouches situated behind the prostate which open into the floor of the prostatic urethra together with the openings of the prostate gland. The prostate gland lies in front of the bladder surrounding the prostatic urethra and secretes the fluid which nourishes the spermatozoa and gives the seminal fluid its characteristic qualities.

While the great majority of these cases will be handled by orderlies and trained male attendants, circumstances may arise which will necessitate that they be cared for by skilled nurses.

ACUTE INFLAMMATION OF TESTICLE AND EPIDIDYMIS

Probably the most common cause of the acute inflammation is gonorrhea affecting the epididymis mainly, although it may be secondary to certain chronic diseases such as gout, or trauma from urethral instrumentation.

Symptoms.—There are pain, swelling, tenderness of the testes and epididymis, and systemic symptoms of anorexia, fever, and general malaise.

Treatment.—The patient is ordered to bed, and the testicle is elevated by placing beneath the scrotum broad strips of adhesive plaster which are fastened to the shaven thighs. Local applications to the scrotum may be made in the form of heat or cold. Probably the application bearing heat which is lightest in weight is the flaxseed poultice. If ice is used it should not be left on continuously, but on for two hours and off for one. An enema should be given daily, and the patient forced to drink water in large amounts. When the condition is due to gonorrhea, the patient should be placed upon individual precautions. After the acute symptoms have subsided, the patient may be allowed up, but the scrotum should be firmly supported by a suspensory for some time.

CHRONIC INFLAMMATION OF TESTICLE AND EPIDIDYMIS

These are secondary to acute inflammations, or due to syphilis or tuberculosis. If syphilitic in nature the patient is given antisyphilitic treatment in the form of mercury and salvarsan. If tuberculous, the best procedure is operative.

Symptoms.—The pain is not so severe as in acute inflammations. In the case of tuberculosis, there may be a sinus in the scrotum discharging pus from the diseased epididymis.

Treatment of Tuberculosis.—Tuberculous epididymitis, when only one side is involved, is treated by epididymectomy (excision of the affected epididymis). These cases require no special nursing care except that they should be placed upon individual precautions and kept out in the open air as much as possible.

HYDROCELE

Lying in front of the testis and epididymis there is a small sac called the tunica vaginalis. This may become filled with fluid causing a hydrocele of the tunica vaginalis. As a rule it is not painful but uncomfortable because of its mere mechanical presence.

Palliative Treatment.—In this procedure a needle or a trocar and cannula are inserted into the hydrocele sac and the fluid withdrawn. After most of the water has been tapped, some surgeons reinject an irritating fluid, such as a mild solution of carbolic and iodine, trusting that the irritation will cause the obliteration of the sac of the tunica vaginalis.

Operative Treatment.—The operative procedure may be done under novocain. The scrotum is washed with green soap, alcohol and ether. The distended tunica is delivered into the wound, incised, part of it cut away, and the remainder sutured behind the testicle proper, destroying the sac.

Post-operative Treatment.—The scrotum is supported upon a bridge and a moderate amount of pressure is applied to it to prevent post-operative bleeding.

VARICOCELE

Lying in the scrotum along with the spermatic cord is a plexus of veins. These very often become hypertrophied or increased in size and number, occasionally causing pain and a dragging sensation in the scrotum. This may be remedied by partially excising the veins through the scrotum, or just above the external abdominal ring. The only post-operative care is the support of the testicles by an adhesive bridge, and the wearing of a suspensory bandage subsequently.

NEW GROWTHS OF TESTICLE

The testicle, as the ovary is, may be a location for cysts, or for spermatocele, dermoids, or carcinoma. In the cases of cancer, a

radical excision of the testicle together with the vas deferens and the lymph glands draining these regions is performed but the operation is attended with very much shock, and the mortality is extremely high.

PROSTATE

One of the most common operations done upon the male genital tract is that of prostatectomy, removal of the prostate gland. This is performed for simple hypertrophy, or for cancer. It is known that the prostate consists mainly of three lobes, the middle coming into close relationship with the urethra and the lateral lobes coming into relationship with the rectum. When the prostate increases in size, it follows the path of least resistance and projects into the bladder, and the increase in the size of the median lobe interferes with the free passage of urine because it obstructs the internal opening of the urethra. This results in frequency of urination, then urinary retention which must be relieved by a catheter, and from frequent catheterizations a condition of cystitis is very often established. The suffering is quite severe, and the only measure affording permanent relief is the removal of the obstruction (prostatectomy).

PROSTATECTOMY

This operation is often preceded by a period of improving the patient's nutrition and his urinary output by regular catheterizations or the use of an indwelling catheter which is left in the urethra and secured to the penis with adhesive. The operation resolves itself into a choice of perineal or suprapubic prostatectomy.

Perineal Prostatectomy.—The perineum is shaved and eight hours before operation the usual soapsuds enema is given. The patient is placed in a lithotomy position with the pelvis raised by sandbags and the prostate is enucleated through the perineum.

Post-operative Treatment.—The retained catheter is connected to bottle drainage and the urine collected. The gauze tampon which usually occupies the space of the removed prostate is taken out on the fifth day; the catheter is removed on the seventh, and from then on the urethra is treated with sounds of various sizes.

Suprapubic Prostatectomy.—In this procedure the prostate

is removed through the bladder. It is done in two stages. The first operation is a suprapubic cystostomy, the second the actual removal of the gland through the existing bladder wound.

First Stage.—As a rule, catharsis is given forty-eight hours previous to the day of operation. Before operation the bladder is irrigated and often some novocain or alypin is injected. The bladder is kept distended and the cystostomy is done under local anesthesia. A button drainage tube is placed in the opening of the bladder and the tube clamped. When the patient arrives in his room the clamp should be removed from the tube and the bladder drained continuously, or intermittently. The diet should be very light and soft, fluids allowed in liberal amounts.

Second Stage.—While some surgeons proceed to enucleate the prostate immediately after cystostomy, the majority wait five or more days before completing the operation. Naturally there will be rather a profuse hemorrhage following the blunt dissection of the gland. This may be controlled by tampons, but a better result is obtained if a bag hemostat is used. This is made of rubber, is inflatable and when distended and placed within the bladder exerts pressure on the bleeding areas. (Fig. 106.) One connection of the bag passes through the urethra, and is the means by which air is introduced. This is removed in twenty-four to forty-eight hours.

The suprapubic wound is freely drained, and at the end of forty-eight hours a button tube is inserted, connected to the bottle drainage and the patient allowed out of bed. At the end of a week the patient is encouraged to void, and as soon as he does so in sufficient amounts, the suprapubic tube is removed. Of course, the urine will leak in small amounts, but the sinus is healed in from the thirteenth to the twentieth day.

Cancer of Prostate.—In the early stages this is treated by prostatectomy. In the late periods, radium is tried as a palliative procedure.

CHAPTER IX

THE SURGERY AND SURGICAL NURSING OF THE URINARY SYSTEM

ANATOMY

The urinary system is composed in a normal individual of the kidneys, the ureters, the bladder and the urethra. The kidneys, usually two in number, are compound tubular glands. They are situated on either side of the spinal column in the region corresponding to the last two thoracic and upper two lumbar vertebrae. The right kidney is at a lower level than the left owing to the presence of the liver on that side. As a rule they are about four inches long, two and one-half inches wide, and one and one-half inches thick. Each kidney is covered by a capsule. There are cases in which the kidneys are fused into one, the horseshoe kidney; or there may be only one kidney present. Occasionally a kidney may have two ureters. (Fig. 30.)

The ureters which connect the kidneys to the bladder vary from twelve to eighteen inches in length. The bladder, which is the reservoir for the urine, is situated in the pelvis behind the pubis. It is in front of the vagina in the female and in front of the rectum in the male. It is a muscular sac, and at its neck gives origin to the urethra. The urethra is about one and one-half inches long in the female, and eight to nine inches in the male. It courses beneath the symphysis pubis in a downward and forward direction; its external orifice in the female is situated between the clitoris and the vaginal opening. In the male it normally runs through the length of the penis.

DIAGNOSTIC KIDNEY PROCEDURES

There is probably no field in surgery which has reached such diagnostic refinement as the diseases of the urinary system. A definite routine has been established which is invariably followed in all these cases, and this varies but slightly under different

conditions and circumstances. All cases, after proper preparation, should have a flat X-ray plate not only of the kidneys, but also the ureters and bladder. This may not only demonstrate the kidneys as diffuse shadows but reveal the presence of urinary

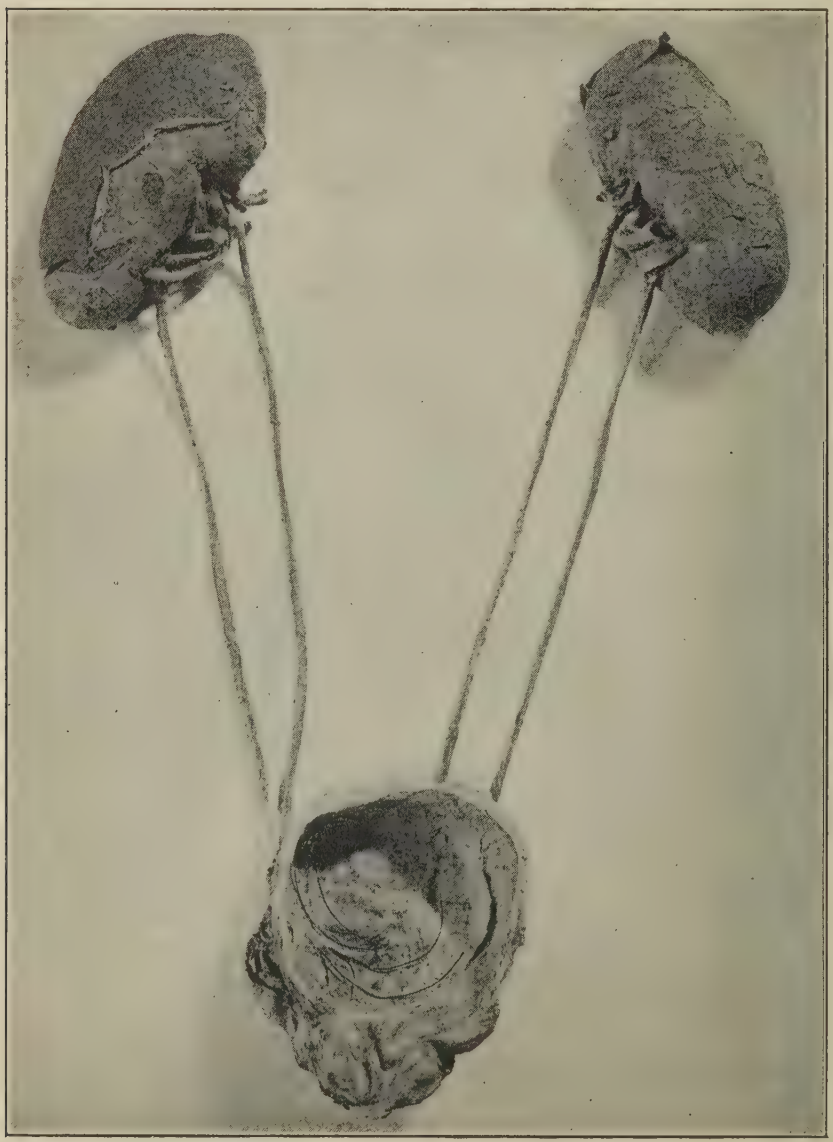


FIG. 30.—ILLUSTRATING KIDNEY WITH DOUBLE URETERS EMPTYING INTO THE BLADDER. (Courtesy of Dr. Lewis F. Frissell.)

calculi. Not only should a careful urinalysis be made, but the intake and output should be charted and a daily bedside specimen of urine should be kept for inspection. All these cases should be given a phenosulphophthalein test. This is a dyestuff which is injected subcutaneously and then excreted by the kidneys. The urine is collected for two hours after the injection, and a quantitative analysis is made of the amount of dye excreted. A complete blood chemistry examination should always be made for the amount of urea, non-protein, nitrogen, uric acid, creatinin, cholesterol and sugar. A cystoscopic examination is performed in the majority of these cases. A *cystoscope* is an electrically lighted metal telescope, shaped like the urethral sound which is introduced through the urethra into the bladder. Not only is the interior of the bladder observed after it has been dilated with fluid, but the openings of the two ureteral orifices are noted. By means of a catheterizing arrangement, small ureteral catheters impervious to the X-ray may be passed into the kidney pelvis and the urine collected from each kidney, and its functional activity determined if a dye like indigo carmine or phenosulphophthalein has been injected previously.

Obstruction to the passage of the catheter may be due to a calculus or a stricture. If the tip of the catheter has been previously coated with wax, a stone may cause a scratch mark which may be seen easily with a magnifying glass after the catheter has been withdrawn. By injecting sodium iodide through the ureteral catheter, the shadow of the kidney pelvis may be demonstrated by X-ray. This picture is called a pyelogram, and is invaluable in locating stones and demonstrating new growths as they project into the kidney pelvis. This iodide will also outline the ureters as well as the bladder.

INFLAMMATORY DISEASES OF THE KIDNEY

The inflammatory affections of the kidney may be either acute or chronic. The acute variety may involve the pelvis of the kidney (pyelitis), or there may be pus formation in the kidney itself (suppurative nephritis). If the pus is retained in the pelvis with a resultant dilatation, the condition is spoken of as a pyonephrosis. (Fig. 31.)

Of the chronic inflammations, the one which interests the surgeon most is tuberculosis.

SYMPTOMS OF ACUTE INFECTIONS OF THE KIDNEY

Pyelitis.—This is an infection of the kidney pelvis occurring often in young female children and in women during pregnancy. It is usually sudden in onset with chills and high fever, and examination reveals tenderness in the costovertebral angle and the urine shows pus. Occasionally the ureter becomes plugged and there is retention in the kidney pelvis.

FIG. 31.—PYONEPHROSIS OF THE KIDNEY, SHOWING ENLARGED KIDNEY WITH ENORMOUSLY DILATED PELVIS. (Courtesy of Dr. Wm. A. Downes.)

Pyonephrosis.—This may be an indirect result of pyelitis, or possibly the combination of stones in the kidney plus infection, which may result in kidney abscess. The symptoms are quite similar to pyelitis, except that the lumbar pain is quite constant, and very often a mass is palpable in the lumbar region. If the ureter is absolutely blocked on the affected side, the urine examination may be negative, otherwise it will contain pus. Cystoscopic examination may reveal pus coming down the ureter with a poor dye excretion, or the catheter may overcome the obstruction of a stone and the kidney pelvis be drained of the pus. If the calculus is the cause of a pyonephrosis, it is spoken of as *calculous pyonephrosis.*

Perinephritic Abscess.—This is usually the result of the perforation of a cortical abscess of the kidney. It results in pain in the lumbar region accompanied very often by swelling and fever.

Treatment of Acute Infections.—In *pyelitis,* the treatment is primarily medical. The patient is placed in bed; fluids are forced to about 2000 c.c. a day, and urotropin, gr. 10 or more, is given by mouth three times a day. If it is thought that the

pyelitis is in some way due to a chronic constipation with a dilated caput coli, colon irrigations are especially indicated. Occasionally the pelvis of the kidney is irrigated directly through a ureteral catheter.

In *pyonephrosis*, the indication is to drain the kidney. This may be accomplished by drainage through the ureter via ureteral catheter, which may be left in place, or, if this is impractical, open operation must be resorted to. Either a pyelostomy, nephrostomy, or nephrectomy is performed, depending upon the location of the pus and the extent of the kidney involvement and destruction. In a pyelostomy, the pelvis of the kidney is incised, the pus evacuated and a tube inserted; in a nephrostomy, the abscess of the kidney is incised and drained, and in a badly diseased and functionless kidney, a nephrectomy or kidney removal is performed.

Ante-operative Preparations for Kidney Operations.—In all kidney operations not only are the lumbar regions carefully shaved and cleansed, but the entire abdomen and back as well. It is extremely important to force fluids on these patients to at least 2000 c.c. to 3000 c.c. a day, and the intake and output must be carefully charted. Opiates should be used with extreme caution because morphine may depress kidney function.

Operation of Nephrostomy.—The patient is placed in the kidney position. This is described in Chapter XVII (see Fig. 84). The kidney is exposed through a lumbar incision, care being taken not to open the peritoneal cavity. The kidney is opened with single or multiple incisions and the abscesses drained with rubber dam or packing. The wound in these pus cases is rarely sutured; as a rule it is left open.

Post-operative Treatment of Nephrostomy.—Inasmuch as urine as well as pus will escape from the kidney through the wound, the dressings should be frequently removed and changed to prevent maceration of the skin. The patient is placed upon forced fluids, their amount carefully measured, and the urinary output approximately estimated. These cases are rather protracted, lasting from six to eight weeks. The nutrition should be particularly watched and every effort taken to maintain or increase the patient's weight by a liberal diet, high in carbohydrates. When they are allowed up, there is often a leakage of urine through the wound, and to prevent the embar-

rassment of a constant urinous odor, a lumbar urinal may be worn.

Nephrectomy.—When it is evident that the kidney has been destroyed to such a degree that it is of little use to the organism, it is much better to remove it completely. A nephrectomy is always done for an acute septic kidney, diffuse pyonephrosis, tuberculosis, or new growths (Fig. 32), provided the physical condition of the patient will permit such an operation, and the other kidney is present and not markedly diseased. The kidney is exposed through a lumbar incision and, if possible, delivered into the wound. The renal artery and renal veins are then isolated and ligated separately as well as the ureter. If the ureter is pathological, it is dissected down until a healthy portion is found, or if the entire length is affected, it might be totally excised.

Post-operative Treatment.—The treatment is similar to that of a nephrostomy. The drainage tubes are removed at the end of three or four days, and the patient is kept in bed for three to four weeks, until the wound has firmly and completely healed.

TUBERCULOSIS OF THE KIDNEY

This manifests itself mainly by symptoms referable to the bladder. There is frequency, urgency, strangury. Examination of the urine reveals pus, often blood and tubercle bacilli. Cystoscope examination, aside from giving evidence of tuberculosis of the bladder in ulcer and tubercle formation, may reveal the tubercle bacilli definitely coming from one kidney. If the disease is unilateral, nephrectomy is the only hope of cure. If the tuberculosis involves both kidneys, then conservative hygienic treatment must be pursued.

RENAL CALCULUS

Renal calculi or kidney stones may be found in the substance of the kidney, in the pelvis, or in the ureter. The stones may be single or multiple, rough or smooth, and may be present in one or both kidneys. (Fig. 32.) The symptoms which they cause are those of renal colic. This is a severe colicky pain in the loin radiating downward to the testicle or vulva. Blood is

FIG. 32.—DILATATIC CALCULUS FOR WHICH NEPHRECTOMY WAS PERFORMED. (Courtesy of Dr. Leila C. Knox)

found in the urine (hematuria) and there is occasionally frequency and urgency with burning micturition.

Treatment of Renal Calculus.—Patients who have a tendency to renal colic, as evidenced by a previous history of attacks or the passage of small calculi, and whose urine contains an excess of urates, should be placed upon a diet which is poor in protein. Alcohol is absolutely prohibited, also tea and coffee. Alkaline drinks should be administered, and the alkaline diuretics, such as acetate, bicarbonate, and citrate of potassium, should be given freely and often.

Operative Treatment.—When there is definite evidence of a stone from the clinical history augmented by positive radiographic and cystoscopic findings, operation is indicated, for it is the only measure which will insure permanent relief. The operations performed for kidney stones are three in number:—pyelolithotomy, nephrolithotomy and nephrectomy (see page 156).

Pyelotomy is a simple incision of the pelvis of the kidney to remove a stone. Following this, the pelvis is usually sutured and a rubber dam drain placed to the line of suture. In spite of this, there may be drainage of urine subsequently, but this usually ceases in a short period of time.

Nephrolithotomy.—In this operation the procedure is similar to a nephrostomy. The usual lumbar incision is made with the patient in the kidney position (Fig. 84), the kidney exposed, and the pedicle, that is, the renal artery and the renal vein, are grasped by the hand of an assistant while the surgeon incises the kidney along the convex border. Under these hemostatic conditions the bleeding is very slight. The calyces of the pelvis and kidney tissue are carefully examined and the stone removed. The kidney is sutured together with mattress sutures of chromic catgut on a blunt, non-cutting needle.

Post-operative Treatment.—The routine procedure in all surgical kidney cases demands that fluids be forced to the maximum. All the urine excreted should be accurately measured and saved for the inspection of the attending surgeon. The elimination must be especially watched, because after this operation urinary suppression is apt to result. Should this unfortunate complication occur, those measures which are described in Chapter III should be instituted immediately. For a day or so the

urine is apt to be bloody; this is not particularly alarming. During this period patients often complain of symptoms simulating renal colic, due to clotted blood passing down through the ureter. The pain is easily controlled by small doses of codein by hypodermic injections. The dressings should be carefully watched, for secondary hemorrhage often occurs in this type of operation.

NEW GROWTHS OF THE KIDNEY

The benign tumors of the kidneys are usually cysts. The malignant are the hypernephromata. The latter are usually insidious in their growth and rarely occasion pain. Hematuria is often the first symptom and then a physical examination may reveal an enlarged kidney. A pyelogram will disclose a tumor encroaching on the kidney pelvis. If there is no evident metastasis, nephrectomy is indicated. Either it may be done through a lumbar incision, or, if the tumor is unusually large, it may be better to remove it through the abdomen. This latter operation is called a transperitoneal nephrectomy.

OPERATIONS UPON THE URETER

The ureter may be incised to remove a calculus (ureterotomy) or it may be removed for chronic diseases such as tuberculosis (ureterectomy). The incision made is usually the abdominal Kammerer type and the approach to the ureter is extraperitoneal.

URINARY BLADDER

The bladder may be the site of injury, acute or chronic inflammations, calculi, or new growths.

TREATMENT OF INJURIES OF THE URINARY BLADDER

The bladder may be lacerated from external violence or in fractures of the pelvis. In all suspected cases the patient is placed under general anesthesia, the bladder is examined through an abdominal incision, and, if injured, the damage is repaired by appropriate suture. As a rule, a drain is placed down to the injured area of the bladder to take care of any urinary leakage which may result. Some surgeons insert a permanent catheter into the urethra; others prefer to catheterize the patient every

eight hours. In either case, great care should be taken that there be no undue intravesical tension. Fluids should be administered liberally, and during the first week, urotropin, gr. 30 daily, is given. The patient is kept in bed for at least three weeks.

INFLAMMATIONS OF THE URINARY BLADDER

Acute Cystitis.—Cystitis may originate in the bladder itself, or it may be secondary to inflammations of the kidney, urethra, or other organs. The symptoms are frequency and urgency of micturition, and a burning sensation when the urine is voided.

Treatment of Acute Cystitis.—Patients should be kept in bed. The pressure about the bladder is relieved by elevating the pelvis so that the intestines will fall away from it, and flexing the knees so as to relax the spasm of the rectus muscles of the abdomen. Hot applications applied over the bladder region are very agreeable, and Sitz baths given about three times daily afford great relief. If the pain is very severe, morphine is given.

If there is great difficulty in voiding because of excruciating pain, a little novocain instilled in the posterior urethra affords great relief. Urine is less irritating when alkaline, and an acid condition may be alkalinized by the giving of sodium bicarbonate or sodium citrate, 20 gr. three times a day. The diet should be bland, non-irritating, and mainly fluid in nature. Irrigations of the bladder may or may not be done, according to the judgment of the surgeon in charge. Irrigating solutions may be of boric acid, and later, when the disease becomes less acute, irrigations of silver nitrate 1-5000 in distilled water may be employed, potassium permanganate 1-5000, or protargol 1-10,000. They are more effective and comforting when given warm.

Chronic Cystitis.—Chronic bladder inflammations may be the result of an acute attack, or secondary to some condition in the bladder itself, as a papilloma or a stone.

Treatment.—The treatment is that employed in the late stages of acute inflammation, namely, irrigations. These should be given daily, after a diagnosis of its etiology has been made. Sometimes, because of stricture of the urethra or inflammation of the testes, irrigations are not practical. These cases are treated by cystostomy (a suprapubic incision into the bladder with the establishment of free continual drainage).

TUBERCULOSIS OF THE BLADDER

Primary tuberculosis of the urinary bladder is extremely rare; it is ordinarily infected secondarily to the kidney, prostate, or testis. The complaints given are usually of frequency, urgency, and often bloody urine.

Treatment of Tuberculosis of Urinary Bladder.—The treatment, of course, should be directed to the primary focus of the tubercle bacillus, and, if the kidney is responsible, it should be extirpated. While this is of prime importance, the patient meanwhile must receive some treatment to relieve the very distressing symptoms of a diseased bladder. In the first place the patient should be kept in good hygienic surroundings. Food should be plentiful, appetizing, and highly nutritious, and every measure available should be taken to insure the strengthening of a weakened, debilitated constitution. The bladder should be irrigated with very hot solutions of boric acid. These are always pleasing, and will relieve much of the pain. If the pain is very severe, some novocain (but never cocaine) might be instilled into the bladder. Tuberculous bladders are ulcerated, and great care must be taken that too much medication is not instilled, because free absorption is apt to take place and poisoning result. Rectal suppositories containing opium and extract of belladonna do much to relieve pain.

Operative Treatment.—This consists in either fulguration with a high frequency current through a cystoscope or a suprapubic cystostomy and the direct treatment of the ulcerated bladder mucosa, with either the actual cautery or chemical caustics. The after treatment is very important. The head of the bed is raised, the bladder drained by continuous drainage, and washed out daily with a bland non-irritating solution through the suprapubic tube. Drainage of the bladder is kept up for about six weeks. It is important to maintain all the rules of strict asepsis in these cases, for nothing is more discouraging than to add secondary infection.

BLADDER STONE

When a stone is present in the bladder, there are generally pain, frequency of urination, and the occasional passage of blood at the end of micturition. The diagnosis of bladder calculi is not so difficult since the use of the X-ray and cystoscope,

although formerly its presence was detected by the metal sound stone searcher of Thompson.

Treatment.—The stone is removed by either litholapaxy or lithotomy.

Litholapaxy.—The patient is placed in the lithotomy position (Fig. 89) and the urethra locally anesthetized. Some employ spinal anesthesia, and others, general. In this procedure an attempt is made to crush the stone within the bladder by means of a lithotrite. This is an instrument introduced through the urethra, and then opened when in the bladder, grasping the stone between its two powerful jaws, and crushing it into smaller pieces. The stony fragments are later evacuated by means of a Bigelow evacuator, which is an instrument designed to suck from the bladder the stone fragments in a water current.

Post-operatively, water should be given in large amounts; the urine should be kept acid, and drainage from the bladder should be free, through an inlying catheter. As a rule this can be removed at the end of forty-eight hours.

Suprapubic Lithotomy.—In this operation the bladder is opened above the pubis; the stone is removed, and the bladder sutured or drained.

Ante-operative Treatment and Operation.—This consists of the ordinary preparation for any abdominal operation. The patient is anesthetized, the bladder is distended fully with either warm boric acid solution or air, and the patient is placed in the Trendelenburg position (Fig. 80). A suprapubic median incision is made, the bladder exposed, incised, and the stone removed with special forceps. The bladder is sutured with a double row of sutures, and the abdominal wound closed or drained.

Post-operative Treatment.—If the wound is sutured tightly, the patient may be permitted up in from ten to fourteen days. If there is suprapubic drainage because of a concomitant cystitis, the tube should be left in for about ten days, and then removed; the patient is allowed up as soon as the suprapubic wound has healed. With very old people, attempts should be made to get them out of bed as soon as possible, for experience has shown that a weakly healed abdominal wound is better than broncho-pneumonia and death which may result if these cases are confined to bed.

NEW GROWTHS OF THE URINARY BLADDER

Tumors of the bladder may be either benign or malignant; the benign variety may be treated through the cystoscope, or by open operation; the malignant ones by open operation and radium.

Cystoscopic Treatment.—This is especially adaptable for cases of small benign tumors of the papillomatous variety. These growths are located with the cystoscope and fulgurated with the sparks of a high frequency current under direct vision. The effect is simply to burn away the tumor tissues.

Operation.—A suprapubic cystostomy is done, and an effort made to extirpate the growth under direct vision by excision. In cases of extensive malignant growths the bladder may be excised in its entirety. The ureters may either be transplanted in the rectum or brought to the skin surface through the abdominal wall. This is an operation of considerable risk, the mortality is high, and the end results extremely poor. When extensive cancer exists it is much better to employ radium.

Radium Treatment.—The solid radium, enclosed within a metallic tube of platinum, is introduced into the bladder through a suprapubic incision, and left in place for a certain number of hours, or it may be introduced through the urethra with a special cystoscopic arrangement.

These cases are often apt to hemorrhage. The bleeding is effectively controlled by irrigation of the bladder with warm boric acid and the introduction thereafter of a 1-1000 solution of adrenalin hydrochloride.

It is quite natural that such patients are nervous and apprehensive, but every attempt should be made to reassure them, rather than administer morphine, for in these chronic cases the opium habit is established very easily, and, in addition, this drug has a depressive action on the kidneys.

THE URETHRA

The diseases of the male urethra are usually treated by the surgeon himself, and as the lesions of the female urethra demand practically no operative interference, the only condition which requires mention is stricture of the male urethra. This develops secondarily to acute inflammations of the urethral canal in which the mucous membrane has been partially destroyed, and

its place is taken by scar tissue. When this tissue contracts it forms a stricture, narrowing the lumen, resulting in difficult micturition, and often complete retention of urine. To relieve this, if catheterization is impossible even by the means of a filiform bougie, a urethrotomy is performed. If the constriction is in the penile portion an internal urethrotomy is performed; if in the deep urethra, an external urethrotomy.

Internal Urethrotomy.—An internal urethrotomy consists of cutting the stricture with an urethrotome (an instrument shaped like a sound containing a hidden knife). The urethrotome is introduced into the region of the stricture, the knife drawn, and the stricture is cut. Sounds are then passed and the strictured area dilated to the caliber desired.

External Urethrotomy.—The patient is placed in a lithotomy position, a filiform bougie is passed into the penis, and an attempt made to pass it through the strictured area. A tunnel sound is threaded along the filiform bougie down to the strictured area, the perineum is incised over the sound, and the stricture, identified by means of the filiform, is cut with a special urethrotomy knife. A tube is passed into the bladder through the perineal incision.

Post-operatively this tube is connected with bottle drainage. Fluids are forced and in about one week the tube is withdrawn and the patient is encouraged to void through the urethra. Sounds are passed about twice a week.

Circumcision.—This operation is performed to relieve a tight prepuce (phimosis), and consists in trimming off the redundant skin and mucous membrane of the penis. In young children the nurse should change the dressing after urination.

CHAPTER X

THE SURGERY AND SURGICAL NURSING OF THE BONES, JOINTS AND TENDONS

FRACTURES

A FRACTURE may be described as a break in the continuity of a bone. While this condition is treated in the main by the surgeon, it affords great opportunity for the nurse to exhibit her skill not only in preparing the necessary things for the treatment of the fracture itself, but even more by conscientiously attending to those details which bring comfort to the patient. A fracture may be *simple,* that is, only involving the bone, or it may be *compound,* in which case the skin and deeper tissues as well as the bone have been injured. Compound fractures are serious and dangerous because the broken skin affords excellent opportunity for the various pathogenic organisms to enter and cause bone infection. For the present, however, our attention will be confined to simple fractures, those in which the skin is not directly injured, although it may be swollen, black and blue, and very tender to the touch.

SIMPLE FRACTURES

A simple fracture may be (1) incomplete, (2) complete, (3) multiple. (1) Incomplete fractures may be subdivided into (a) fissure fractures, (b) green-stick or bent bone, (c) depressions, (d) separation of a splinter. (2) Complete fractures may be sub-grouped by (a) the character and the direction of the line of fracture, as for example, spiral, transverse, Y or T; by (b) the site of the fracture, as, for example, the upper third of the humerus; and as (c) extending into the joint.

Symptoms.—It is obvious that as soon as any bone is broken there is ordinarily some deformity about the site of fracture. This may be due to the hemorrhage of the torn vessels of the periosteum, or the deep muscles; or it may be due to the fact that the fragments of the injured bone are displaced. In the

normal bone, a balance exists between the muscles which are attached to it. When the bone is broken, this equilibrium is destroyed and the muscles attached to each fragment tend to pull it in their own direction, thereby causing displacement. This is not true, however, in all cases. Very often one fragment is telescoped or driven directly into the other. This is spoken of as an impacted fracture.

The aim in all fractures is to restore the bone fragments as near to their anatomical condition as possible, and after this has been accomplished, the next thing to do is to keep the fragments in their reduced position. The first process is usually spoken of as "reduction," and the second process as "immobilization."

TREATMENT OF FRACTURES

Emergency Treatment.—All fractures and limbs suspected of being fractured should be immediately immobilized by any means which are at hand. Not only will this prevent further deformity but it will diminish the pain and incidentally reduce the amount of shock. The splints should not be disturbed until a surgeon arrives.

Reduction of Fractures.—Before any fracture is reduced, it is very important that either an X-ray picture be taken of the bone or the bones involved or that a fluoroscopic examination be made and that the same be repeated after the fracture has been reduced.

Fractures are reduced as a rule under general anesthesia, either gas, gas oxygen, or ether, or local anesthesia. This is done because it is less painful, the patient is easier to control, and the muscles are completely relaxed instead of being in a condition of spasm. Attempts at reductions are done by the surgeon as soon as possible after the injury.

There are, however, certain fractures which do not yield to manual reduction because of the following reasons: (1) Too much time has elapsed between the time of fracture and the period when the surgeon was called upon to treat it; (2) the muscular pull between fragments is so great that manual reduction is impossible; (3) the fragments although reduced are not able to be retained in their reduced position; (4) because of the imposition of bone fragments, muscle or torn periosteum, the fragments cannot be brought into apposition. These fractures

are treated either by means of apparatus designed for the gradual reduction of fractures, or by open operation.

Immobilization of Fractures.—Immobilization (the means of keeping fractures at absolute rest) has for its ultimate aim the healing of the divided bone ends by the growth of new tissue or "callus formation." There are many methods designed to hold fractures in apposition. They may be classified as follows: (1) bandaging, (2) strappings, (3) splints (wood, wire and plaster), (4) extension and traction appliances, (5) mechanical means applied through open operation.

It is a general rule in all fractures that the limb affected should always be placed in a position to favor the complete relaxation of the muscles which would have a tendency to pull the fragments apart, and, since the longer fragment can always be more easily controlled, it should be made to follow the position attained by the shorter fragment.

Bandages and Strappings.—While bandages and strappings are employed more in sprains and dislocations, they are occasionally used in certain fractures. Fractures of the jaw are very often controlled by a simple four-tailed bandage (Fig. 166, page 446); a fracture of the clavicle may be kept in position by a Velpeau bandage (Fig. 161, page 442) or a Syms strapping. Both the four-tailed and the Velpeau bandages are described in the chapter on bandaging. Strapping is most frequently used when one or more ribs are broken. It forms an efficient method for immobilizing the chest, at the same time permitting the fractured ribs to heal. It should be emphasized that the adhesive plaster dressing should never be directly applied over the area of fracture, with the exception of fractured ribs, because, with the swelling of the limb and the pressure of the adhesive, an ulceration of the skin is apt to ensue. The result is that a clean fracture may be converted into a compound one. Another rule in the application of adhesive dressings is that the part over which the adhesive is to be applied should be shaven of all hair.

SPLINTS

A splint is an apparatus for preventing movement of a joint, or between the ends of a broken bone. Since materials used for splints must of necessity be hard, firm and unyielding they should always be padded well. There is nothing more distressing than

to see a patient with a simple fracture of the radius just above the wrist in which the splint was not only insufficiently padded but was applied too tightly. The result is a forearm which has become blistered, ulcerated, and paralyzed from the pressure, the function of the wrist being irretrievably impaired; and the stiff, smooth fingers are an ignominious monument to the carelessness of the surgeon and the attending nurse. Let it be an unfailing, unalterable rule that all fractures in splints of any description be regularly inspected so that the swelling of the part never becomes so great as to impair the circulation. The pulse at the wrist in fractures of the arm and forearm and the pulse at the dorsum of the foot in fractures of the lower extremity should always be palpable after a splint has been applied. This is simple and safe assurance that the blood flow to the limb is not seriously impaired. Very often a patient will complain of pain in an area other than that of the fracture. The splint should always be carefully inspected to determine the source of the discomfort. Occasionally in circular casts, it is a good plan to cut a window in the plaster in the area of pain so as to relieve the pressure which is invariably causing the distress; some surgeons insist that all circular casts be cut longitudinally. By doing this, the incidence of ulcers from pressure will be reduced to the minimum.

Before any splint is applied it is of prime importance to cleanse the injured part. The nurse, always being mindful of the injury, should do this gently and carefully, causing as little pain as possible. This procedure should be completed by dusting the skin of the broken limb with talcum powder.

Splint Materials.—Any material which is light and strong is suitable for a splint. The following are some of the more widely used materials:

Wood.—Wood has been used for centuries to support broken limbs. Probably the best splints are the basswood. Basswood splints usually come in sizes of $18 \times 4 \times \frac{1}{4}$ inches. When they are padded carefully with cotton, they make good temporary splints, and because of the lightness of the wood, they can be cut to any desired size. The one great disadvantage is that it is impossible to mould them accurately.

Plaster of Paris.—This is perhaps the most widely used splinting material in civilian practice, and, beyond doubt, its wide-

spread application is justifiable. It is easy to obtain, strong, moderately light, and when soft lends itself to accurate and easy moulding. Plaster of Paris is best handled in the form of plaster of Paris bandages. The manner in which they are made is given in Chapter XXI. There are two ways in which these bandages may be applied. They may be used as bandages or "moulded splints."

Plaster of Paris Bandages.—These are applied as any other bandage, the limb having been previously padded with non-absorbent cotton. Extreme care should be taken to apply the bandages smoothly, without wrinkles and rather snugly. The number used is dependent upon the desired thickness of the cast. After this has been obtained, the cast may be further smoothed by applying an excess of plaster and polishing the same with long strips of cheese cloth moistened with peroxide of hydrogen. Plaster usually dries in from one to eight hours. For the first thirty minutes, the limb should be held until the plaster has partially dried, because the cast may become distorted by pressure of surrounding objects.

While it is not a universal practice, a great many surgeons deem it advisable to cut all circular casts in the direction of their longitudinal axis, in two parallel lines, diametrically opposed. The reason for this is obvious. Should the limb become swollen, the danger of any untoward complications, such as pressure necrosis, with a subsequent Volkmann's paralysis, is materially lessened. When the cast has been cut, a bandage is applied to hold the segments in place. Not only does cutting down a cast insure a "safety first" policy, but it becomes very convenient to do so when baking and massage are employed, as the cast may be quickly removed and efficiently reapplied after each treatment.

If, for some reason, the surgeon should decide to leave the cast intact, and to have it cut at a subsequent date, it must not be forgotten that dried plaster is almost stone-like. The method of cutting casts is given on page 455 (see Fig. 168).

Moulded Plaster of Paris Splints.—As the name implies, these are simply splints made up of plaster of Paris which, when soft, may be moulded. They are very extensively used because they are easily applied, safer than the circular cast, and save the labor of cutting through plaster. They may be used for all

fractures of the extremities. Assume a fracture of the radius just above the wrist, a so-called Colles fracture. The manner of applying a moulded splint to this type of fracture is herewith briefly given: The length of the splint to be used is measured with a piece of gauze, in this case from the elbow to the metacarpo-phalangeal joint, and, in addition, the width of the arm is noted. This pattern of the splint in gauze is laid flat upon some smooth surface, either glass, marble, or board. A moistened plaster bandage is rolled back and forth over the gauze pattern, until the desired thickness of the splint has been attained. A piece of Canton flannel usually lines the inner side of the splint. The soft plaster, lined with flannel and a thin layer of cotton, is applied to the anterior surface of the forearm, and bandaged snugly in place. The anterior splint in this way can readily be moulded to the shape of the arm. After the plaster has hardened, the bandage is removed, all the rough edges of the splint smoothed and a muslin bandage reapplied. Some surgeons in addition to an anterior splint apply a posterior one. The technic is identical for all of the moulded variety. Very often a splint will be made double in length and be bent upon itself in the shape of a letter U, forming a joint anterior and posterior one. This type is known as a "sugar-tong" splint. It finds a very practical application in fractures of both bones of the forearm.

Spicas and Jackets.—When a long bone is broken, such as the femur, or the pelvis, heavier splints are required because greater strength is necessary to overcome the powerful contracting influences of the muscles of the thigh. Splints in this region have but little value aside from their first aid application. If the surgeon desires to use plaster for these conditions a spica bandage of plaster of Paris is employed. This extends from the region of the free border of the ribs down to the toes on the affected side.

The technic of the application of the plaster is the same, but there are several factors which are a little different and demand special mention. First the mechanical, for after all, plaster has only a certain tensile strength. If this is exceeded, the plaster is apt to crack and break, rendering the spica useless. In order to prevent this, it is customary to reinforce the cast, especially in the lateral region, i.e., from the hip to the knee

and over the anterior aspect of the thigh. The reinforcing material may be strips of basswood, wire mesh, or sometimes longitudinal strips of plaster of Paris in the form of moulded splints. Then, in applying the cast, inasmuch as the lower abdominal region is included, sufficient space must be allowed for the possible distention of the small and large intestines. In other words, ample room must be left for the patient's appetite. This is accomplished by laying two or three folded towels on the abdomen, and winding the plaster so as to include them temporarily, removing them after the plaster has hardened.

Since the spica winds about the genitals and anal orifice, great care must be taken that there is no undue pressure against these organs, and that the patient is able to defecate and urinate without difficulty. In children whose control is apt to be lax or involuntary, it is customary to coat the cast with shellac, thus rendering it impervious to the urine. Spicas, as well as all other complicated plaster work, are applied with great facility and more efficiently if the patient is resting on a *Hawley table.*

The Hawley table, or modifications of it, is of such mechanical construction that any part of the bony framework of the patient may be held in any desired position for any length of time without the aid of very much assistance. This, of course, is a wonderful advance over those methods which required a limb to be held in a certain position by a nurse or doctor until the plaster could be applied. Not only may the Hawley table be used for the application of casts, spicas, and plaster jackets, but it is a convenient means to steady a limb and obtain traction if necessary, during the course of an open operation upon bone.

Coats or jackets made of plaster which cover the patient from the neck well to the region of the thighs, find their application in dislocations and fractures of the vertebrae due either to accidental causes or to disease, such as tuberculosis of the spine. They may be applied either with the patient resting on the Hawley table, or with the patient lying across supporting straps, or suspended by the head.

METHODS TO OBTAIN TRACTION

In some cases, the fragments of the fracture are overriding to such a degree that were the limb permitted to heal in this position great deformity and shortening of the leg or arm would

result. To overcome this, and to correct the overlapping of bones, traction may be applied. Nothing has developed the use of traction more than the Great War. For there, not only did the surgeon have to deal with fractured limbs but with fractured limbs plus injuries to the soft parts (compound fractures). To overcome these difficulties, which are practically impossible to handle if the limb is encased in plaster, an attempt is made to maintain reduction by traction often combined with suspension.

Through its agency, those muscles are relaxed which by their contraction have resulted in malpositions of the fracture. In addition, if properly applied, it automatically secures the proper alignment of the bone ends and prevents the fragments from being displaced, thus avoiding injuries to muscles, blood vessels, or nerves.

In civilian practice, traction was practiced frequently for fractures of the femur either through a Buck's extension or a Hodgen's splint. Briefly, the Buck's extension is made by applying to the lateral aspects of the leg a piece of adhesive plaster about four inches wide, reaching from above the knee to below the sole (Fig. 33). Between the free ends of the adhesive a piece of wood, five by three inches, is attached. This acts as a spreader, and a means by which weights may be attached and traction obtained.

The Hodgen's suspension splint (Fig. 34B), which is really a forerunner of the various splints developed recently, is simply two parallel iron bars bent slightly in the region of the knee. The lower extremity is placed between these two bars, resting on several cross pieces. The limb is raised from the bed by cords attached to the splint and traction is obtained. Further traction may be obtained by combining this with a Buck's extension.

As the Buck's extension depends for its pull upon large areas of skin being covered by adhesive, it was found impractical during the war, because extensive wounds of the skin and deeper tissues often complicated the fracture. So newer methods of traction were developed—namely, the stocking traction (Fig. 33 A) and the Sinclair skate (Fig. 33 C). The former employs a light-weight sock from which the toes have been removed. The sock is glued to the leg, ankle and foot

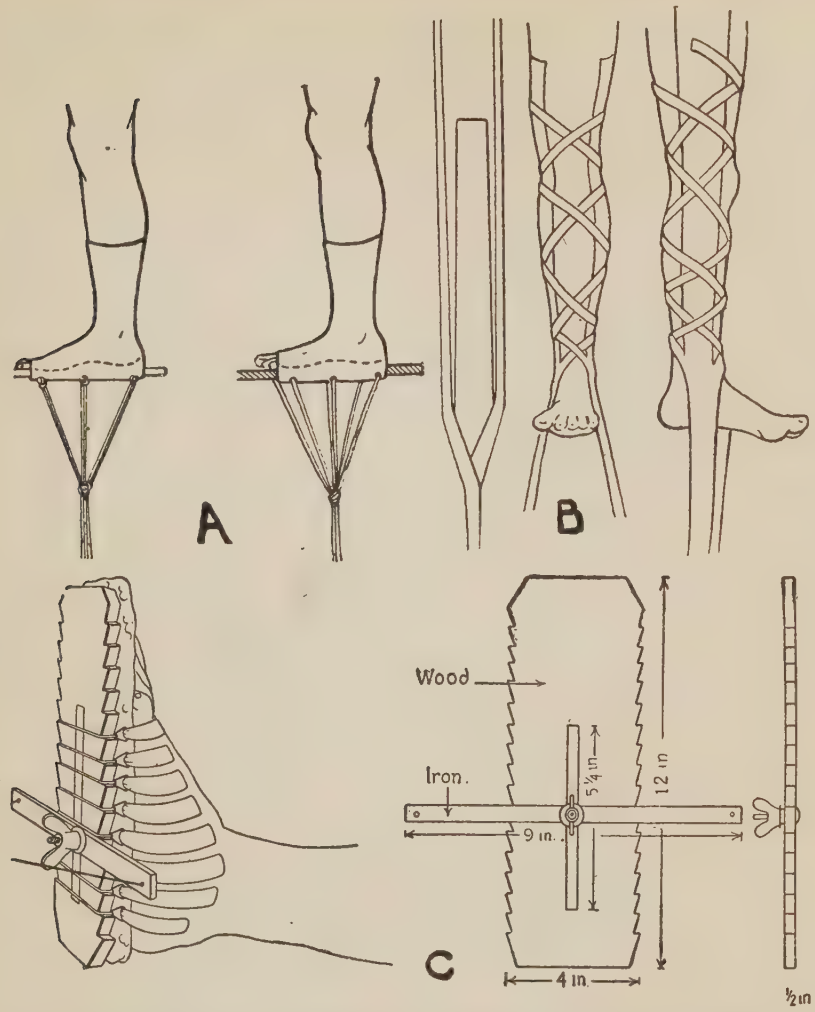


FIG. 33.—METHODS OF APPLYING TRACTION. *A*, stocking traction; *B*, adhesive plaster traction; *C*, Sinclair skate. From the Manual of Splints and Appliances, Medical Department, United States Army.

except at its sole, and a piece of splint wood is introduced between the sock and the sole of the foot. Traction is obtained by means of a cord passed through the sock and splint. A further refinement is the Sinclair skate; this is a piece of board attached to the foot by adhesive strips or glued strips. The glue that is used may be made after the following formulae, and directions

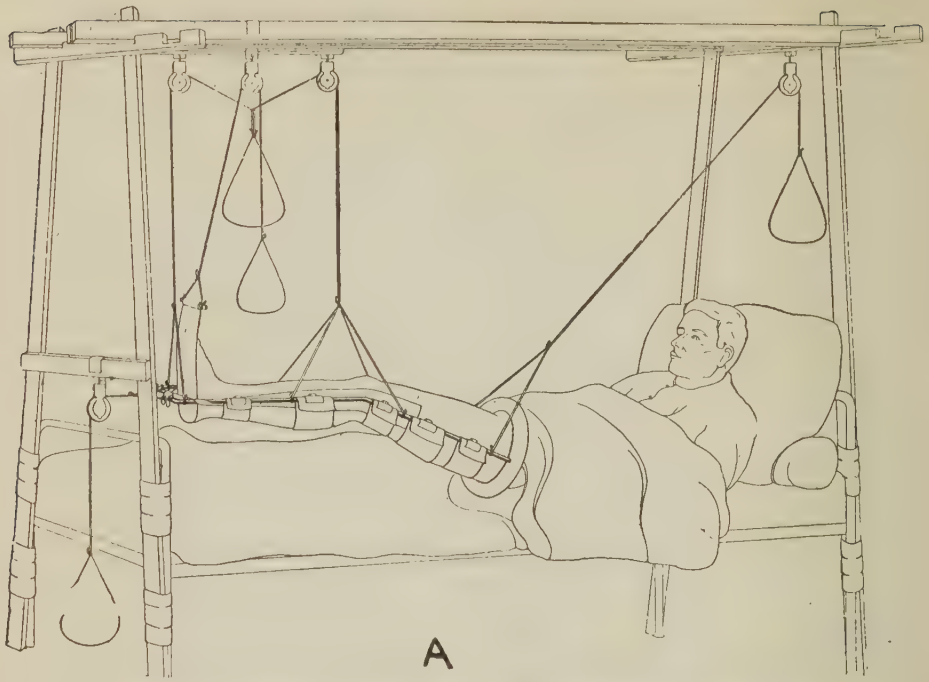


Fig. 34A.—Traction Leg Splint. *A*, Thomas traction leg splint with suspension.

obtained from the Manual of Splints and Appliances (Medical Department, United States Army).

SINCLAIR'S GLUE

Glue	50	parts
Water	50	"
Glycerine	2	"
Calcium chloride	1	part
Thymol	1	"

The glue is heated in a water bath to about 100° F. It is painted on the skin; the last coat given is painted in a direction against the growth of hair.

RESIN AND TURPENTINE GLUE

Resin	50	parts
Alcohol	50	"
Benzine (pure)	50	"
Turpentine	5	"

To the powdered resin, one-half the alcohol is added, then the turpentine and benzine. The measure is washed with the remain-

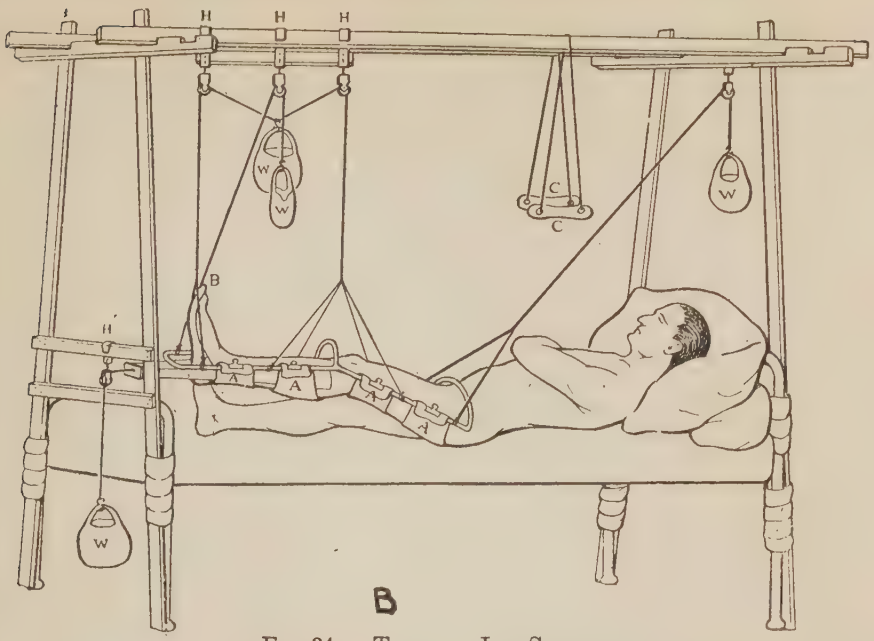


FIG. 34B.—TRACTION LEG SPLINT.

B, wooden bed frame.

For traction by weight and pulley and overhead counterweight suspension.

Application for lower limb injuries.

Limb in anterior thigh and leg splint, Hodgen type.

Uses:—

For suspension of limb from overhead support in injuries of thigh and leg.

A. Supporting slings clipped to rods of splint.

B. Cloth glued to sole of foot attached to counterweight arranged to maintain right-angle dorsal flexion.

C. Hand grips by which patient may change his position in bed.

H. Strap iron hooks movable on upper cross-bar of frame but screwed to short wood bar to maintain pulleys in proper relative position.

W. Open canvas weight bags.

This splint is used simply for a frame to sling the leg in case the nature of the wounds makes the Thomas splint impossible. The traction straps should be attached directly to the weight and pulley, and should not be attached to the splint.

By careful adjustment of the slings the position of the bone fragments can be controlled. From the Manual of Splints and Appliances, Medical Department, United States Army.

ing alcohol and the contents poured into a bottle. The bottle is always kept tightly corked. The glue may be removed with alcohol or ether. No heat is necessary for its application and it should be applied as thinly as is possible.

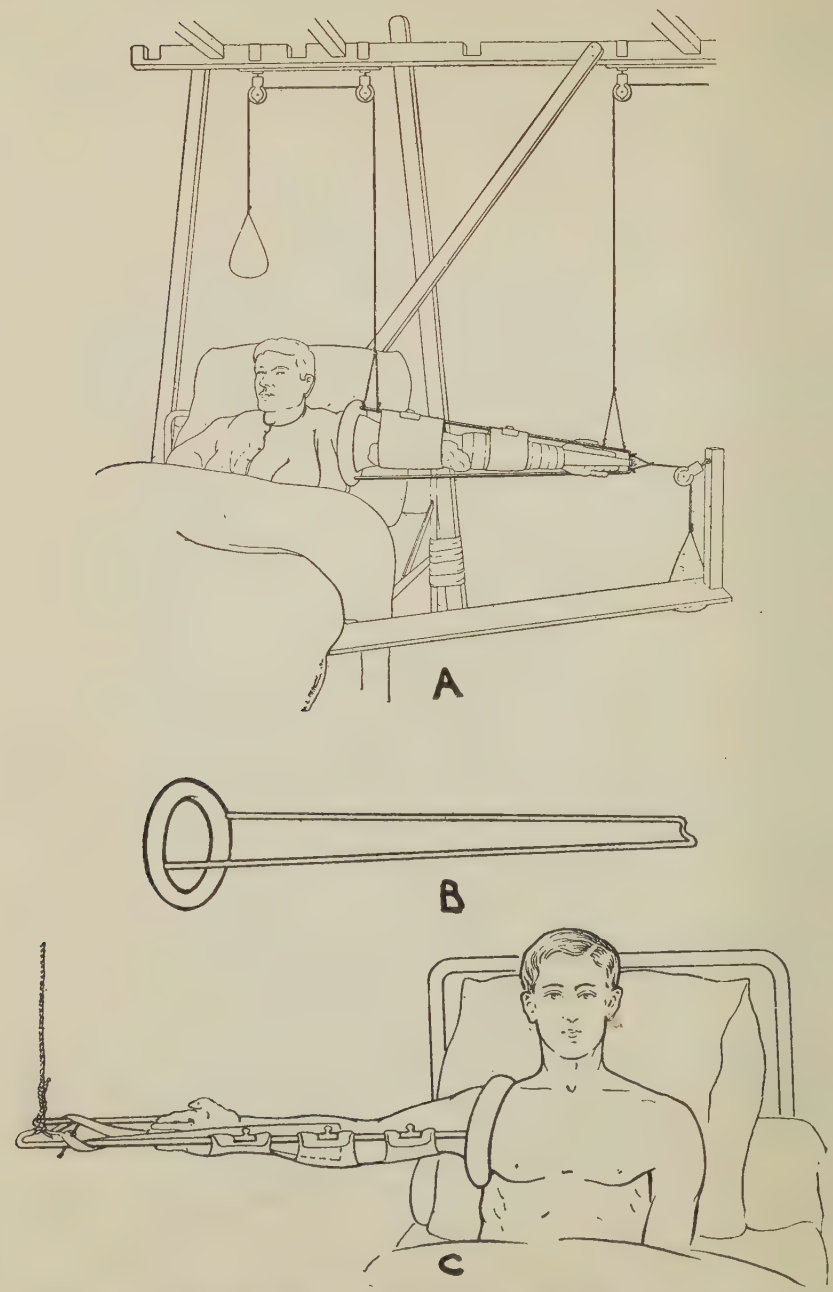


FIG. 35.—TRACTION ARM SPLINTS. *A*, Thomas traction arm splint; *B*, Thomas arm splint; *C*, Thomas traction arm splint. From the Manual of Splints and Appliances, Medical Department, United States Army.

Skeletal Traction.—When skin traction fails to effect a reduction, skeletal traction often succeeds. This type of traction is obtained by direct pull on bone itself by inserting either a nail or tongs directly into the bone and attaching the weights directly to these appliances. The Steinman nail is driven directly through a bone, as for example the femur or the oscalcis. In using tongs only the points of the tongs are driven through the cortex of the bone. It is really remarkable how overriding bones which have resisted skin traction will be pulled into place by these simple procedures.

Suspension.—While traction is an important element, suspension has enhanced its value by rendering greater comfort to the patient, and making the surgical dressing of the wounds much easier. The limb is usually suspended to an overhead

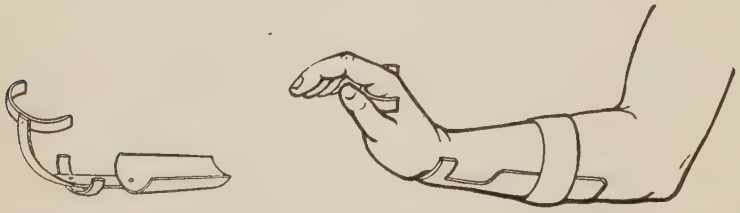


Fig. 36.—Jones "Cock Up," or "Crab" Wrist Splint. From the Manual of Splints and Appliances, Medical Department, United States Army.

wooden or metal frame (Fig. 34B) developed from the original Balkan frame. This consisted of two uprights with a cross piece at each foot of the bed supporting a horizontal bar. The frame now in use is a quadrilateral variety and is illustrated in Fig. 34B.

To this frame may be attached various pulleys, or these pulleys may be run on trolleys as shown in Figs. 34A, 34B, and Fig. 35.

There are several splints which have been recently developed, and although their application and suspension is the concern of the orthopedist and surgeon, the nurse should have a knowledge sufficiently great to secure the desired appliances at the splint room, and in the event of anything occurring to them in the absence of the attending doctor, she may apply first aid. The ones most commonly used are those mentioned in the Manual of Splints and Appliances issued by the Medical Department, United States Army, and illustrated herewith.

Thomas Traction Arm Splint.—This is used for fractures of

the shoulder joint, shaft of the humerus, elbow joint, and forearm (Fig. 35).

Jones "Cock Up" or "Crab" Wrist Splint.—This is intended for injuries to the wrist, or to maintain dorsal flexion of the hand in injuries to the wrist, and in injuries to nerve and muscle causing wrist drop (Fig. 36).

Thomas Traction Leg Splint.—This is for injuries to the shaft of the femur, knee joint, and leg (Fig. 34A).

Hodgen Type Splint.—This is for injuries to the thigh (Fig. 34B).

OPEN OPERATION FOR FRACTURES

In those fractures, which are not compound, where reduction has been impossible, it is often necessary to perform an open operation, reduce the fracture under the direct vision of the surgeon, and then hold the fragments in place by some mechanical measure. The means of accomplishing this are many. Some use wire, others Lane plates; the latter are pieces of metal which bridge bones together, the plate being held fast to the bones by screws (Fig. 37).

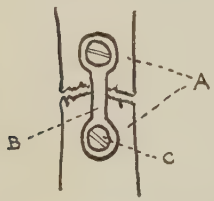


FIG. 37.—LANE PLATE. *A*, fractured bone; *B*, Lane plate; *C*, screws.

Occasionally, although the bones are in good position, union by callus formation fails to take place. To stimulate bone growth a piece of bone may be taken from some other part of the body, as a graft from the tibia, and this is inserted into the fractured bone ends. Inasmuch as infection is very much dreaded in these operations, an exaggerated aseptic technic, or Lane's technic, is employed. This is a method whereby everything that goes into or comes into contact with the wound is touched not by gloved hands, but by instruments. The technic is briefly outlined in Chapter XVIII. The wound, of course, is closed without drainage, and the limb put up in some splint or fixation apparatus.

COMPOUND FRACTURES

These are quite serious because of the danger of infection. If the bone is protruding through the skin, no attempt should be made to reduce it until a surgeon arrives. Under direction, these cases should be given prophylactic injections of tetanus anti-

toxin and anti-gas-bacillus serum and then if the shock is not too severe, the patient should be taken into the operating room. There, under general anesthesia, the skin adjacent to the wound should be shaved and cleansed, and together with the wound, should be scrubbed for ten minutes with green soap and water, thoroughly irrigated, then cleansed with benzine, alcohol and ether. All bruised and contaminated tissue should be cut away (debridement), the fracture reduced, and the wounds either packed open wide or sutured. If at any time a temperature should suddenly arise, a gas-bacillus infection should be suspected, and no time should be lost in notifying the surgeon, who will institute treatment (see Chapter IV).

OSTEOMYELITIS

This is an inflammation of the medulla or marrow of the bone. It may be acute or chronic, and generally results from a bacterial infection. All those compound fractures of the war, due to shrapnel and machine gun bullets, were complicated, as a rule, by osteomyelitis in varying degrees.

Symptoms.—The symptoms may consist of great pain referred to the bone affected, high fever, rapid pulse, and general malaise. There may be swelling, redness, and marked tenderness on pressure over the involved area.

Treatment.—The treatment is operative. An attempt is made to give the bone free drainage by incision through the skin and muscles and then sufficient cortex of the bone is removed to permit the pus in the medulla to drain freely. To insure free drainage the wound is packed with gauze, and to clean up the infection, the bone and wound are Dakinized by the various methods described in Chapter XX. If the condition is complicated by fracture, the limb is treated by suspension and traction, plus the Dakin treatment.

Because of the hardness and unyielding character of bone it will take a long while for the dead bone in the medulla to form a line of demarcation from the living, and that is why these cases of osteomyelitis linger so long before they are healed. The dead bone which often comes away in spicules at a dressing, or which is removed at some subsequent operation, is spoken of as a sequestrum.

Inasmuch as the majority of these cases will suffer for some

time from a continual low grade toxemia, it is important to look after their general condition. These patients should be given as much fresh air as possible, kept on a high caloric diet, and although confined to bed, the muscles of the affected limb should be given daily massage whenever possible. This will insure proper nourishment and maintain muscle tone, for it is well known that muscles not in active use are apt to undergo atrophy. The temperature should be carefully watched, since any sudden rise might be indicative either of retention of pus somewhere in the wound, or the starting of a new focus in the same bone or another one.

AMPUTATIONS

Fortunately, today, amputations are but rarely performed, and limbs which years ago would have been sacrificed, are saved now by the newer advances of surgical treatment. Amputations are mutilations. They are employed as final measures and their indications are sharply defined and clearly cut.

Ante-operative Treatment.—The area through which the amputation is to be done and the skin for a considerable distance above and below should be shaven and cleansed very carefully. If there are any open sinuses they should be protected by packing and sterile dressings, so that their discharge will not contaminate the wound.

To prevent hemorrhage during amputation there are several methods devised which aim to compress the blood vessels supplying the limb in question.

Esmarch's Method.—This method attempts to squeeze all the blood out of the limb by applying an elastic bandage which is wound spirally from below upward, well above the region of amputation. At the upper limit, an ordinary rubber tubing tourniquet is applied and fastened. The elastic bandage is then removed. This is not applicable in septic conditions, nor in cases of tumors.

Lister's Method.—Here the limb is elevated for a few minutes and the ordinary tubing applied in a horizontal fashion as a simple tourniquet.

Tourniquets.—These should always be applied well above the region to be amputated, and should be sterilized. When the amputation is to be done near the hip or the shoulder, strips of

sterile bandage should be applied around the tourniquets. These are held firmly by an assistant to prevent the tourniquet from slipping. Some surgeons prefer to use Wyeth's pins, elongated steel pins which are pierced through the muscles, and the tourni-
(Fig. 38).
quet in pressing against these is prevented from sliding off

AMPUTATION OPERATIONS

The technic of the operation is variable. Some surgeons will inject all nerve trunks with novocain before cutting them. The bone stump is treated in various manners, so that a full armamentarium of bone instruments should always be on hand. Amputation wounds are usually drained. The dressings applied should be large and pressure should be evenly exerted either by adhesive strips or bandage. As a rule the stump should be elevated. Sometimes a small splint is applied to the stump to immobilize it in a more efficient manner.

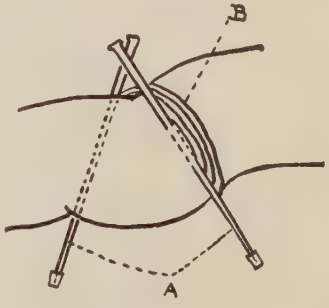


Fig. 38.—Method of Applying Wyeth's Pins. *A*, Wyeth's pins; *B*, tourniquet.

After Treatment.—These patients are apt to suffer from considerable shock, so not only must this condition be watched for, but also the danger of secondary hemorrhage. It should be routine practice to have an emergency tourniquet set very near the patient's bed so that should bleeding occur no time may be lost in arresting the hemorrhage. If the oozing is marked, the dressing may be reinforced or changed in twenty-four hours, although it is better to wait forty-eight hours.

Occasionally when the wound has almost healed it becomes necessary to apply pressure to certain flaps or skin areas to relieve tension. This pressure can be obtained by thin bandaging or by adhesive strappings. In bandaging, it is always to be remembered that the turns which pass over the stump should be begun from above downward and on the side where the longer flap is. Sometimes when the flaps have been cut too short, it may be necessary to apply traction to pull the muscles over the stump.

While healing is in progress, gentle massage to the muscle groups will do much to maintain their tone and health.

If the amputation is one of the lower extremity, the patient should be carefully taught the proper use of crutches. Crutches should not press into the axilla but the weight of the body should be sustained by the hand resting on the cross piece of the crutch. Special instructions should be given as to how to descend and ascend a flight of stairs, cautioning the patient to hold the banister with one hand while using the other hand to hold the supporting crutch. To prevent the crutches from slipping they should always be equipped with rubber tips.

After the stump has healed no time should be lost in fitting it with an artificial limb.

JOINTS

A joint is an area of contact of two or more bones surrounded by a capsule. Joints are subject to sprains, dislocations, injuries and infections. A *sprain* is an injury to a joint with possible rupture of some of the ligaments and tendons but without dislocation or fracture. A *dislocation* is simply a disturbance or derangement of the normal relationship of bones entering into the formation of the joints. All sprains and dislocations should be given the benefit of an X-ray examination because a fracture may accompany either condition.

Treatment of Sprains.—The present day trend in the treatment of sprains is to apply some agent which will stop further effusions into the joint cavity, aid in the absorption of blood which has already been poured into the joint at the time of the injury, give support to the injured part, and yet permit the patient to move the traumatized joint. One of the most effective ways to accomplish this is by the application of adhesive strappings. If the swelling about the joint is very severe, it is often advisable to apply ice for the first twelve hours, usually in the form of wet applications. This will do much to reduce the swelling. The joint is then ready for strapping. This is done by the surgeon. The adhesive is applied in such a manner as to insure support, relieve the strain from the ruptured ligament, and yet permit free movement of the affected joint. The patient is then advised to walk about and to use the joint as much as possible.

The strapping is left undisturbed for about a week and is renewed if necessary. Very often, when the ligaments have definitely ruptured, some surgeons will put the limb up in a moulded splint. Baking, massage and passive movements are allowed and are usually supervised by a nurse. Six weeks or more may elapse before the healing of the injury is completed. Strapping is used very extensively in sprains of the ankle, wrist and knee.

Treatment of Dislocations.—The patient is usually given an anesthetic and by the proper manipulation, the dislocation is usually reduced and the part put at rest for forty-eight hours, after which physiotherapy should be begun provided no fracture is present. Occasionally, however, it is impossible to reduce a dislocation by manipulation, and then an open operation must be performed.

INJURIES TO JOINTS

A joint may be injured by direct or indirect violence, and as a result it may become swollen and painful. The increase in size may be caused by an effusion of either blood or serum within the joint. If it is simply an effusion of serum, it is spoken of as *hydrarthrosis*, or "water on the knee"; if blood, a *hemarthrosis*.

Treatment.—The present day practice is to aspirate the fluid from these joints and then apply either a bandage, strapping, or an elastic knee support. This is immediately followed by active motion. Occasionally, the cartilages of the joint may be deranged by an injury. The resulting symptoms may be so annoying, and motion of the knee so interfered with, that the removal of the cartilage, usually the internal one, is necessary. An *arthrotomy* (incision of a joint) of any variety must be done under the strictest aseptic precautions, because an infection of any joint is exceedingly serious. It results not only in the loss of motion of the joint, but the infection may cost the patient his life.

INFECTIONS OF JOINTS

Aside from the medical infections which cause swelling and pain of the joints, such as rheumatism and chronic osteoarthritis, acute infections may occur either as metastatic lesions in a bacteremia, secondary to an osteomyelitis which has perforated the

adjacent joint or through penetrating wounds. As a rule, these patients appear acutely ill, the temperature is high and local examination reveals a swollen joint, which is red, tender and hot.

Treatment.—The treatment consists in repeated aspirations of the pus from the joint, followed by lavages of the joint with some mild antiseptic fluid or saline. If the response to this treatment is not immediate, then free drainage of the joint by incision is used. Active mobilization of the joint, following this procedure, is highly important. This method of active motion in which the joint is either actively or passively moved every two hours to four hours is known as the *Willems treatment.*

Chronic Infections.—The most frequent forms of chronic inflammation of the joint, excepting those that follow rheumatic conditions, gonorrhea and syphilis, are those due to tuberculosis. In this condition, surgery endeavors to eradicate the disease and effect a permanent cure by stiffening the joint. This really entails a resection of the joint followed by a complete immobilization through the application of a plaster cast until bony union has occurred. This operation is known as an *arthrodesis.*

Arthroplasty.—Occasionally following infection or injury, very definite limitation of motion may occur, or the joint may become absolutely stiff. Under certain circumstances, it may be deemed advisable to attempt the restoration of joint motion. The various operations which endeavor to mobilize a frozen joint, and supply a new one by the implantation of fascia or fat between the bones, come under the head of arthroplasty. Very brilliant and successful results have been obtained in the knee and elbow.

SURGERY OF THE TENDONS

The tendons are bands of fibrous connective tissue arising from muscles and attached to bones. Motion is established through their pull by means of muscle contraction.

Tendons as they glide over bone are often separated from the bone itself by small sacs known as *bursae.* In many parts of the body in order to insure smooth motions, tendons are enclosed in sheaths known as tendon sheaths. These are present in the fingers.

Tendon Injury.—When tendons are cut by accident, as evidenced by loss of function of the part to which they are attached,

no time should be lost in reuniting the divided ends by tendon suture, known as *tenorrhaphy*. Active motion should be encouraged when ordered by the surgeon.

Tendon Transplantation.—Occasionally in such diseases as poliomyelitis, infantile paralysis, in which certain muscles become paralyzed, the tendons lose their power. The tendons of normal adjacent muscles may then be transplanted to take the place of paralyzed ones and in this way function may be restored. These operations are spoken of as "tendon transplantation."

Following certain orthopedic conditions, tendons may be shortened. For example, a patient may walk on his toes because the tendon Achilles is shortened. The orthopedic surgeon to overcome this may perform a "tenotomy" or, in other words, cut and lengthen the tendon.

Tendon Sheath Infections.—When the sheaths of tendons are involved by infection (suppurative tenosynovitis) the sheaths should be adequately incised and drained, and either the part soaked in hot saline or wet dressings applied. Motion should be started almost immediately.

CHAPTER XI

THE SURGERY AND SURGICAL NURSING OF THE NERVOUS SYSTEM

The nervous system consists of the cerebrospinal and the sympathetic or autonomic systems. The cerebrospinal division is made up of the brain with the twelve pairs of cranial nerves and their peripheral modifications, and the spinal cord with its thirty-three pairs of spinal nerves and their peripheral modifications. The autonomic division comprises the sympathetic ganglia and their ramifications.

FRACTURES OF THE SKULL

While these injuries should really be included in the chapter on the osseous system, they are so closely and intimately related to brain injuries that a brief discussion of this subject might be appropriate here. Fractures of the skull are invariably due to direct trauma, the result of blows or falls upon the head, and anatomically they may be divided into those of the vault and those of the base. Either of these may be associated with brain injuries.

Fractures of the Vault may be simply fissures in the bone, or the bone may be actually depressed and splintered into several fragments.

Fractures of the Base are usually more serious because of the greater danger of injuring the important brain structures in this location. Either of these may be accompanied by injuries to the blood vessels of the dura or pia mater, or by actual laceration of the brain substance.

Symptoms.—As a rule following any fracture of the skull, the patient is either dazed from the concussion, or in stupor from the shock to the nerve centers of the brain. If some blood vessels in the dura or pia mater have been torn, causing an intracranial hemorrhage, a compression of the brain occurs, resulting in unconsciousness and coma. The period of unconsciousness is vari-

able, lasting a few minutes in some cases and in others terminating in death. Occasionally, a patient may regain consciousness only to lapse off into another coma because of a gradually increasing "cerebral compression" due to a slowly developing subdural hemorrhage compressing the brain tissue.

Physical examination of the head is variable. The scalp may or may not be contused or lacerated. Occasionally in fractures of the vault, the depression of bone may be felt. In fractures of the base there may be bleeding from the nose, sometimes the ears, and occasionally the pharynx. Convulsions may or may not be present, but it is very important for the nurse not only to record these, but especially to note where the tremors start and exactly what areas of the body are involved. This may be of aid to the surgeon in the localization of the brain injury. Respirations as a rule are irregular, often of the Cheyne-Stokes type (periods of increased respirations followed by periods of very slow respirations), the pulse is slowed, and blood pressure readings invariably show a progressive elevation, especially if there is increasing intracranial tension. This may also cause a "choked disc" (serous inflammation of the optic nerve). This may be seen with an ophthalmoscope, an instrument through which the interior of the eye is inspected. The remainder of the physical examination may reveal changes in the reflexes and evidences of frank paralysis.

Lumbar puncture is of great aid in diagnosis, for with an intracranial hemorrhage not only is the spinal fluid bloody, but it is under greatly increased pressure.

X-ray of the skull is important in locating the line of fracture, especially in those of the vault, but it has little value in those of the base.

TREATMENT OF FRACTURES OF THE SKULL

The majority of these cases are treated absolutely conservatively and the number subjected to any operative procedure is minimum.

As these patients are in shock, they should be treated for this condition first, but they should never be placed in shock position. In fact, the head should be slightly elevated and fixed between two pillows. The room in which they are placed must be quiet and darkened, and all visitors are prohibited.

If there is bleeding from the nose, it is advisable to gently irrigate the nasal fossae with warm sterile boric solution to prevent the clot from becoming foul through infection. In cases with bleeding from the ear, the canal should be swabbed clean and then packed with sterile cotton.

Bowel movements, of course, should be free, and if the patient is unconscious, daily enemas must be given. If the bladder is at all distended, the patient must be catheterized, and this may have to be repeated every eight hours unless incontinence is present.

Unconscious patients must not only be kept exceptionally clean and free from the excretions of urine and feces, but they must be turned every few hours so as to prevent pressure necrosis and bed sores. These are always a sad commentary on nursing care even though at times they are absolutely unavoidable. If the skin around bony prominences such as the sacrum, heels and elbows is carefully bathed with alcohol, gently massaged and powdered, there is very little danger of necrosis taking place, particularly if these regions are elevated for a few hours each day by inflated rubber rings.

If the patient should become wildly delirious as occasionally happens, hyoscine hydrobromide by hypodermic injection or paraldehyde by rectum may be necessary to quiet him.

If the signs of intracranial tension appear to be increasing, lumbar puncture is often quite effective therapeutically because it draws off spinal fluid and permits the brain to expand. Glucose in 50 per cent. concentration intravenously, or a concentrated solution of magnesium sulphate, will aid greatly in diminishing cerebral edema by extracting fluid from the brain tissue.

THE TREATMENT OF COMPLICATIONS OF FRACTURES OF THE SKULL

COMPRESSION OF THE BRAIN

Intracranial hemorrhage may be extradural or subdural. The extradural bleeding invariably results from a rupture of one of the branches of the middle meningeal artery. Subdural hemorrhage is due to a rupture of one of the vessels of the pia mater, or a laceration of brain tissue. The bleeding causes compression of the brain as it lies within the rigid bony cavity of the skull. The operation of temporal craniotomy endeavors not only

to expose the middle meningeal artery, but even if this is not bleeding, to decompress whatever subdural hemorrhage pressure there is by relieving the tension on the dura.

Subtemporal Decompression.—The operation itself is not difficult and is usually performed under local anesthesia (see page 236). A curved incision is made in the temporal region, the temporal muscle incised, and the underlying bone exposed and an opening made into the skull by means of a trephine (Fig. 114, Fig. 115). This is a metal instrument which by virtue of its circular serrated end cuts out a button of bone. After the bone has been removed, the underlying dura is exposed. Better exposure may be obtained by enlarging this opening by clipping away additional bone with bone-cutting forceps, or if the surgeon prefers to keep the bone intact, he may make two more trephine openings and connect them with a Gigli saw. This will remove one triangular plate of bone which may be replaced later. If the bleeding has been of extradural origin, the clot may be removed and the bleeding middle meningeal artery found and ligated, or special Cushing clips (small silver clips) applied. If, however, there is bulging of the dura, it is incised, the clot liberated, and the source of the bleeding sought. The dura is then closed with interrupted sutures. The bone, which has been kept in warm sterile saline, is replaced as a rule into the skull, and the wound closed with or without drainage. A good tight pressure bandage is applied over the entire head.

After Treatment.—Patients should be kept very quiet in a darkened room and watched very carefully because peculiar mental symptoms often follow in the wake of a fractured skull. If they are unconscious, all those nursing procedures already mentioned should be religiously followed. Certainly all these cases, whether they have been operated or not, should be kept in bed for a minimum of twenty-one days. Visitors should be few, and excitement nil. The headache which often persists for weeks is very distressing, but may respond to certain of the coal tar products, as aspirin, phenacetine or antipyrene.

Scalp Wounds.—The head is always thoroughly shaved in the region of the laceration, which is cleansed thoroughly as outlined in Chapter XVII, and then sutured.

Depressed Fractures of the Vault.—The head is shaved completely and iodinized. If the patient is unconscious, no anes-

thetic is required; if not, local anesthesia has been found quite satisfactory. After exposure of the depression, the depressed bone is elevated with forceps or periosteal elevators, and those fragments which are splintered very badly are removed with rongeurs or punch forceps. If complicating this there is intracranial hemorrhage, it may be necessary to add to this procedure a subtemporal decompression.

BRAIN ABSCESS

Occasionally, septic complications or intracranial suppuration may follow compound fractures of the skull, cerebral injuries, infections of the middle ear, and disease of the mastoid antrum. The diagnosis is sometimes very difficult, and the treatment is dependent upon the location of the focus. As for abscesses in other parts of the body, the immediate indication is drainage. In the brain abscess this presupposes a craniotomy (already outlined) with drainage of the abscess cavity.

MASTOIDITIS AND SINUS THROMBOSIS

This is invariably a complication of acute middle ear suppuration (otitis media). As a rule, an attempt has been made to drain the middle ear by incising the drum. This is usually done under gas, and the tympanic membrane is incised by a small spear-like knife (myringotome). The drainage is kept free by wiping the meatus clean with cotton several times a day. In spite of this, however, the pus may spread to the mastoid cells (mastoiditis) and it may enter the region of the lateral sinus (really a vein running in a groove of the temporal bone) and a sinus thrombosis may result. These conditions are treated by active surgical intervention.

Ante-operative Treatment.—The hair in the region of the ear should be shaved for a considerable extent, and if the jugular vein is to be ligated, the neck should always be very carefully prepared.

Operation.—The operation for acute mastoiditis consists in laying open and gouging out the mastoid cells, and if a sinus thrombosis is present, in exposing the lateral sinus. In case the sinus is involved before it is incised, the vein into which it drains (internal jugular) is ligated in the neck. The reason for this is to prevent the spread of infection down the jugular vein

into the general circulation. After the vein has been ligated, the sinus is incised, the clot removed by careful flushings with warm saline solution, and the sinus packed.

After Treatment.—Patients suffering from a sinus thrombosis are very sick. As a rule, they are septic and, like all those cases, require plenty of fluid and sufficient calories to supply the energy their constitutions demand to fight the bacteria in the blood. Not only should they be given saline freely by rectum, but, if necessary, also glucose infusions of from five to ten per cent. in strength. If patients are anemic, tranfusions of blood are indicated, and should be given frequently until the blood cultures are negative, or the red blood cells and hemoglobin have increased to within normal limits. The wounds are dressed daily, cleaned carefully and packed anew; the dressings are held in place by bandages. (Described in Fig. 154.)

TUMORS OF THE BRAIN

The brain may be the seat of a tumor either benign or malignant in nature. As the mass within the cranial cavity grows, it crowds the brain and produces signs of compression with its resultant symptoms. In addition, there will be other physical signs dependent upon the area of the brain that is infiltrated by the new tissue, or compressed by the tumor mass. If the motor area is pressed upon, there may be paralysis; if the speech area is involved, there will be paralysis of those muscles which they innervate or loss of function of the nerves supplying the organs of special sense, as the eye, ear and nose.

Treatment.—If the tumor mass is localized, an operation is done similar to the one described under intracranial hemorrhage. In other words, an exploratory craniotomy is performed, and the trephine opening is made in that portion of the skull overlying the brain tumor area.

Occasionally, the tumor may be extirpated in toto, but if it is found to be inoperable, a plate of bone is removed in the temporal region, and the brain permitted to herniate against the temporal muscle. This operation is called "subtemporal decompression." Sometimes in tumors of the cerebellum, part of the occipital bone is removed, or a suboccipital decompression is done. This procedure temporarily relieves intracranial pressure, and with it, the terrible persistent headaches which torture these

unfortunate individuals almost to distraction. Patients are confined to bed for three to four weeks.

SURGERY OF THE SPINAL CORD

The surgery of the spinal cord is really limited to one operation (*laminectomy*). Its object is to expose the spinal cord for examination in those cases suffering from cord pressure due either to a tumor mass or bone fragments of some vertebral fracture. The patient is placed in the position illustrated in Fig. 100. The procedure consists in making an incision over the desired vertebrae, retracting the muscles attached to the vertebral column, exposing the laminae and spines of the vertebrae, which are then removed with rongeurs, laminectomy forceps, saws, and chisels, exposing the dura of the spinal cord. This is then carefully incised and an exploration of the cord is made. The dura is then sutured and the muscles drawn over it. A moulded cast is applied over the back well into the trunk, and the wound permitted to heal.

SURGERY OF THE SPINAL NERVES

Neuritis (inflammation of the nerves) is really a medical condition, but the wounds of nerves are very important from a surgical standpoint. If a motor nerve is cut or pressed upon so that the nerve fibers are destroyed, the muscle structures supplied by it become paralyzed, and the nerve below the point of incision, or pressure, atrophies, although the part above, that which is connected with the nerve cells, lives on. This is important because if the continuity of the nerve is reëstablished by suture, the nerve will regenerate by growing along the path of the degenerated segment. The strictest asepsis must be maintained in all these operations. If the nerve is simply pressed upon by callus of a healing bone all that is necessary is to remove the pressure; but if the nerve has been recently divided, it should be immediately sutured end-to-end with a very fine round needle with chromic catgut. After this is done, the wound is closed, and the limb placed in that position in which the tension upon the recently sutured nerve will be minimum. A plaster splint is applied, and at the end of one week or ten days, active and passive motions are begun so as to keep up the nutrition of the muscles. Massage and electrical stimulation should also be begun around this period.

The splint may be removed in about six weeks to two months. It should not be forgotten that nerve regeneration is a very slow and tedious process, and very often as much as two years will elapse before the complete, or even partial restoration of function will ensue. The patient should be encouraged to massage the muscles involved so as to prevent atrophy and he should be taught how the faradic and galvanic electrical currents are applied, so that when attendants are no longer around, he may give himself those treatments which will mean a functioning extremity rather than a paralyzed one.

If the operation is done some time after the original injury the process is more difficult and the various plastic nerve operations will have to be performed. The after care is the same as that required for recent cases.

CHAPTER XII

RADIUM AND X-RAY

Radium and X-ray have enjoyed a great therapeutic popularity within recent years, and have been used very extensively in the treatment of various diseases. There is no doubt that some of their effects have been remarkable. But, while they are very valuable adjuvants to surgery, the use of radium and X-ray was never intended to supplant surgery, but rather to aid it.

RADIUM

Radium is a radioactive element obtained from an ore, carnotite, which is found especially in the region of the Belgian Congo. It is extremely expensive, costing about $70,000.00 a gram. Radium, when not in use, should be left in a leaden box under lock and key. It may be used as a salt, or as an emanation which is called *Radon* and which is a radioactive gas possessing the same biological properties as a radium salt, but as a gas it is more efficiently and effectively handled.

Radium is applied in the treatment of many skin diseases, and has been an effective remedy in controlling gynecological bleeding due to benign growths such as fibroids, but its most popular indication has been in the treatment of the various types of malignancies. It depends for its action upon the fact that it destroys lymphoid and neoplastic tissue. In fact all radiotherapy depends upon the law of Bergone and Tridondean, which states in substance that immature cells and cells in an active state of division are more sensitive to X-ray than are cells which have already acquired their fixed adult morphological or physiological characteristics.

Radium may be used as a surface application, in which the radium is simply placed on the surface for a certain number of minutes or hours, or it may be used internally in the form of needles or seeds (implants).

The length of time that the radium is applied depends entirely upon the size, depth and volume of the area to be treated and upon the amount of radioactive substance used and its distance from the skin.

Precautions in Handling.—Radium must never be handled with anything but instruments because of the possibility of burning the hands. It is extremely important that the nurse be constantly on her guard to see that the radium or any of its applicators or seeds are neither destroyed nor thrown away. For example, the number of applicators which have been inserted should always be known, and when they have been removed, great care should be taken to safeguard them from careless loss. All packings and dressings which are removed should be saved while radium treatment is in progress, and in gynecological patients, all vaginal pads should be examined routinely for applicators and seeds which may have been discarded. In any radium treatment, it is paramount that the time of application and the time of its removal be charted.

Precautions After the Use of Radium.—It is extremely important that those areas which have received radiotherapy applications be carefully guarded against the use of heat and cold, and the counter irritations of plasters and ointments. These irradiated areas are susceptible to the slightest irritation.

X-RAY

X-ray was discovered by Roentgen in 1895. The underlying principle is the passage of a current of electricity of high voltage of 100 to 200 kilovolts with low amperage through the vacuum tube which has a tungsten target as anode.

There is practically no difference in the therapeutic application of X-ray and radium. X-ray, however, has a greater field of usefulness in dermatology, in which the lesions are superficial and the areas to be treated are quite extensive. It has been quite effective in curing skin conditions such as acne, the various dermophytoses, psoriasis, etc., which have been resistant to the usual forms of medical therapy. It is cheaper than radium. In the treatment of malignancies, in which it is used extensively, it is really intended to supplement radium, mainly to crossfire the large drainage areas of the lymphatic vessels and glands, while the primary lesion is usually treated with radium. It is used

quite frequently in bleeding fibroids, in which the abdominal application of the ray destroys the Graafian follicles of the ovaries. This acts exactly like castration, with the result that an artificial menopause results.

The precautions after its use are similar to those which are employed in the use of radium.

CHAPTER XIII

SURGICAL DIETETICS

Diet is indeed a most important post-operative consideration. No two patients can be nourished alike, and it is a grave mistake to feed them in a routine manner as is so often done. The type of operation performed, the physical condition, the age, and the general post-operative behavior are all important factors in determining the kind of food, the amount and the frequency of the feedings. Patients who have had a colostomy performed certainly must be dieted differently from those who have had a gastroenterostomy. A woman of sixty will not be able to digest the regular hospital diet with the ease of a young boy. Then again, while the diet may be perfect when under supervision of the nurse, obliging relatives and kind friends may bring food and delicacies which may prove detrimental to the health of the patient. It is not unusual to see gastric disturbances after visiting days, due to candy and fruit which have been smuggled in by visitors. This evil should be tactfully and carefully controlled.

In the discussion of surgical dietetics, to facilitate matters, it will be best to first consider the diet following a simple operation, such as hernia, appendicectomy, ventral suspension of the uterus, and simple plastic gynecological operations.

LIQUID DIET

After a patient has recovered from the anesthetic, he asks for water, and inasmuch as there is bound to be nausea and vomiting following most operations, water is not permitted until two hours after the last vomiting. Of course, it is rather difficult to judge which is the last vomiting, but this can be learned by experience. As a rule, water is given in teaspoonful doses, moderately warm, although some surgeons will order it ice cold. If the patient tolerates this well, more may be given if desired, but

he should never be allowed to drink promiscuously and freely. It is not advisable to allow fluids or "liquid diet" until the day following operation. The liquids commonly used are broths, gruels, tea, egg albumen, and lemon juice. About five ounces of these are given at a time. The second day after operation, milk may be added.

Milk is almost a perfect food; it is quickly digested in the stomach, is entirely absorbed, has a high caloric value and provides considerable nourishment. There are some people who cannot tolerate plain whole milk. This may be modified occasionally by adding barley water, lime water, plain water, seltzer, vichy, or a little brandy.

While it is not good policy to use alcoholic beverages, such as brandy or whisky, sudden withdrawal of these from patients who have been accustomed to alcohol for years might bring on delirium tremens. For these chronically alcoholic individuals it is sometimes advisable to give one-half to one ounce of whisky three times a day. On the other hand, some surgeons use it as a stimulant, prescribing it for weak and debilitated patients the first few days after operation.

The fluids should be served at frequent intervals according to the desire of the patient; whenever possible they should be served warm and always attractively. If they do not agree with the patient, and cause vomiting, their administration should cease. On the third day, as a rule, after the patient's bowels have been moved either by a cathartic or by an enema, a selected soft diet is allowed.

SOFT DIET

The following foods are appropriate for a soft diet. They may be varied and grouped according to the taste of the patient:

Cereals.—Wheatena, hominy, oatmeal, cornmeal, farina, cream of wheat.
Eggs.—Soft-boiled.
Vegetables.—Baked, mashed, or boiled potatoes.
Macaroni.
Desserts.—Ice cream, baked custard, rice, tapioca, or cornstarch pudding.

If this is well borne, within another day the patient may be shifted to a convalescent diet.

CONVALESCENT DIET.—For each day of the week.

Total quantity of milk allowed not over 1250 c.c. (2½ pints) daily.
6:00 a.m. Milk, 210 c.c. (7 ounces) if desired.

Breakfast
Coffee or tea, with milk and sugar, or milk.
One egg, or fresh fish, or plain stew.
Cereal with milk and sugar.
Toast and butter, or rolls or bread (white, Graham, or brown).

Dinner
Broth or soup with barley or vegetables.
Bread and butter. Milk.
Potatoes, baked, boiled, or mashed.
Rice, macaroni, or hominy.
Beef, chicken, or fish.
Pudding, ice cream, or fruit.

Supper
Tea or milk. Toast and butter, or bread.
Egg.
Cooked fruit (baked or stewed apples, prunes, rhubarb, apricots, pears).
At 8:00 p.m., milk, 210 c.c. (7 ounces).

PARTICULAR FOODS FOR SPECIFIED DAYS

Sunday

Breakfast	*Dinner*	*Supper*
Wheatena	Chicken	Egg
One egg	Baked potato	Prunes
	Orange	

Monday

Breakfast	*Dinner*	*Supper*
Hominy	Roast-beef	Egg
Stew	Mashed potato	Pears or apricots
	Rice pudding	

Tuesday

Breakfast	*Dinner*	*Supper*
Oatmeal	Fresh fish, hominy	Egg
Egg	Boiled potato	Stewed apples
	Ice cream	

Wednesday

Breakfast	*Dinner*	*Supper*
Wheatena	Chicken, baked potato	Egg
Fresh fish	Macaroni	Rhubarb or prunes
	Tapioca pudding	

Thursday

Breakfast	*Dinner*	*Supper*
Hominy	Boiled beef, rice	Egg
Egg	Mashed potato	Baked apple
	Baked custard	

FRIDAY

Breakfast	*Dinner*	*Supper*
Oatmeal	Fresh fish	Eggs
Egg	Boiled potato	Prunes
	Macaroni	
	Ice cream	

SATURDAY

Breakfast	*Dinner*	*Supper*
Cornmeal	Chicken	Egg
Stew	Mashed potato	Apricots or pears
	Hominy	
	Cornstarch pudding	

Approximate Values to be Given

	Protein	Carbohydrates	Fat	Total Calories
Men	100 gm.	300 gm.	90 gm.	2500
Women	80 gm.	300 gm.	80 gm.	2200

REGULAR DIET

This should be composed of the food to which the patient is normally accustomed, and should consist of a good mixed diet. It is not necessary to outline it in detail. Those foods should be selected which the patient enjoys, which are easily digestible and which need not be fried in fat. An example of such a diet is the following one:

Total quantity of milk allowed must not exceed 750 c.c. or 1½ pints.

Breakfast

Coffee or tea with milk and sugar, or milk.
Bread and butter.
Two eggs to each patient in male wards.
One egg to each patient in female wards.
Cereal with milk and sugar.
Fresh fish. Hash.

Dinner

Soup.
Meat or fish.
Potatoes, baked, boiled, or mashed. Bread and butter.
Spinach, squash, boiled onions, beets, sweet potatoes, macaroni, tomatoes, corn.
Pudding, or fruit. Milk, 180 c.c. or 6 ounces.

Supper

Tea or milk. Bread and butter.
Cooked fruit (prunes, apples, rhubarb, apricots, pears).
Cold meat. Eggs.
Cereal with milk and sugar. Milk toast.

DIET FOR DIABETES

When certain diseases, such as diabetes or nephritis, complicate surgical conditions, the patient often undergoes a pre-operative dietetic preparation, so that the best possible physical state is attained before the operation is performed. It is a well-known fact that patients who suffer from diabetes mellitus, a disease in which the sugar content of the blood is high and sugar appears in the urine, are extremely poor operative risks. To begin with, they take their anesthetics poorly, their tissues are rather low in vitality, become infected very easily, and are slow in healing. Then after operation, they are apt to pass into a diabetic coma, a very serious complication, usually resulting in death. In order to give these patients the best post-operative chance by rendering them less liable to coma, infection, and slow wound healing, every attempt should be made to reduce their diabetes to the minimum, or to render them sugar-free.

The pancreas secretes a substance which enables the tissues of the body to utilize carbohydrates. When the pancreas is diseased as in diabetes mellitus, the patient is unable to assimilate as much carbohydrate as a normal individual, and it accumulates in the blood in the form of excess sugar, which is excreted in the urine.

In figuring a diet for a diabetic, the object is to begin with a minimum of carbohydrates, and to gradually increase them to the quantity which the diseased pancreas can take care of without being overtaxed. The laboratory signs of too much carbohydrate are high blood sugar and sugar in the urine.

The final diet must not contain more carbohydrate than the patient can use but it must at the same time contain enough food to maintain good nutrition (maintenance diet). Such a diet can easily be prepared for a mild diabetic, but not for a severe one. In the latter case, the maintenance diet contains more carbohydrate than the patient can take care of and his blood sugar remains high. In such a case, *insulin* (an artificially prepared pancreatic substance) must be used to supplement the deficient action of the patient's pancreas.

It is given in unit doses hypodermatically before each meal, starting with small doses which are gradually increased until the carbohydrate of each meal is completely utilized and no sugar is present in the urine. Too much insulin lowers the blood sugar below normal and results in *hypoglycemia*. This is really a con-

dition of shock and is recognized by unconsciousness with a slow weak pulse, a cold clammy skin, and superficial shallow respirations. Glucose should be administered intravenously immediately, and as soon as consciousness is regained, orange juice should be given by mouth. In the event that insulin is not deemed necessary, the following list of diets may be prescribed by surgeons to control the diabetes:

Standard Strict Diet.

Breakfast

2 eggs. Coffee with 45 gm. cream.
Ham, 90 gm.
Butter, 15 gm. on biscuit during the test period; cooked with the eggs if no biscuit or bread is taken.

Luncheon

Meat, steak or chops, 120 gms.
Green vegetables (from list), 2 tablespoonfuls.
Butter, 15 gm. with green vegetable if no biscuit or bread is taken.
White wine, 2 claret glasses, or whisky or brandy, 2 tablespoonfuls.

Afternoon tea with 15 gm. of cream.

Dinner

Clear soup.
Fish, 90 gm.
Meat, beef, mutton, turkey, or chicken, 120 gm.
Green vegetable, 2 tablespoonfuls.
Salad with 15 gms. of oil in the dressing. Cream cheese, 30 gm.
Butter, 30 gm. on fish, meat, or vegetables if no bread or biscuit taken.
White wine, 2 claret glasses, or whisky or brandy, 2 tablespoonfuls.
Demi-tasse.

Bedtime

Bouillon with one raw egg.
Protein, 112 gm.; nitrogen, 18 gm.; fats, 160 gm.; calories, 2200; omitting ham, protein, 94 gm.; nitrogen, 15 gm.
For convenience in determining the carbohydrate tolerance, the following biscuits may be used, as the percentage of carbohydrates is practically constant:—Huntley and Palmer breakfast biscuit which contains 5 gm. carbohydrate; Uneeda Biscuit, which contains 4.6 gm. carbohydrate.

Standard Diet with Restricted Protein.

Breakfast

2 eggs. Bacon, 15 gm. Butter, 20 gm.
Coffee with 45 gm. of cream.

Luncheon

1 egg. Bacon, 15 gm.
Lamb chops, ham, or beefsteak, 60 gm. Butter, 40 gm.
Salad with 15 gm. of oil in dressing.
White wine, 2 claret glasses, or whisky or brandy, 2 tablespoonfuls.

Afternoon tea with 15 gm. of cream.

Dinner

Clear soup.
Butter, 30 gm.
Roast pork, beef, mutton, turkey, or lamb chops, 90 gms.
Green vegetables.
Salad with 15 gm. of oil in dressing. Cream cheese, 30 gm.
White wine, 2 claret glasses, or whisky or brandy, 2 tablespoonfuls.
Demi-tasse.

Bedtime

Bouillon with one raw egg.

Protein, 62 gm.; nitrogen, 10 gm.; fat, 180 gm.; total calories, 2500. Omitting 30 gm. of butter and ½ ounce of bacon, calories equal 2250.

Green Days.

Breakfast

1 egg, boiled or poached. Cupful of black coffee.

Dinner

Spinach with hard boiled egg. Bacon, 15 gm. Salad with 15 gm. of oil.
White wine, ¼ liter, or whisky or brandy, 30 c.c.
4:30 p. m. Cup of beef tea or chicken broth.

Supper

1 egg, scrambled with tomato and a little butter. Bacon, 15 gm.
Cabbage, cauliflower, sauerkraut, string beans, or asparagus.
White wine, or whisky or brandy, 30 c.c.
Sodium bicarbonate, 15 to 30 gm. in 24 hours.

Protein, 32 gm.; nitrogen, 5 gm.; carbohydrate about 5 gm.; fat, 67 gm.; calories, 575.

General Diabetic Diet List.

(May take freely.)

Soups.	All meat soups and broths, to which vegetables, egg or cheese may be added.
Meats.	All fresh, smoked, and cured meats except liver, poultry and game, without sauces or gravies containing flour.
Fish.	All kinds except oysters, clams and scallops, cooked without bread crumbs or meal; all dried, salted, smoked or pickled fish.
Eggs.	Prepared in any way without flour.
Fats.	Butter, lard, suet, olive oil, or other fats.
Cheese.	All kinds, especially cream, Swiss, English and pineapple.
Salads and Vegetables.	Beet greens, Brussels sprouts, cabbage, cauliflower, celery, chicory, cresses, cucumbers, egg-plant, endive, kohlrabi, leeks, lettuce, okra, pumpkin, radishes, rhubarb, salsify, sauerkraut, spinach, string-beans, tomatoes, and vegetable marrow.

Pickles made from these vegetables unsweetened; ripe olives.

Fungi. Mushrooms and truffles.

Condiments. Salt, pepper, cayenne, paprika, curry, cinnamon, cloves, English mustard, nutmeg, caraway, capers, vinegar, and piquant sauces in small quantities.

Dessert. Jellies made from gelatin, custards and ice cream made with eggs and cream; all sweetened with saccharin and flavored with vanilla, coffee or brandy.

Nuts. Butternuts.

Cream. Not over 90 c.c. a day.

Beverages. Tea or coffee, sweetened with saccharin and with portion of cream allowed. Whisky, brandy, rum, and other distilled liquors up to 3 ounces a day. Light wine or Moselle wine, claret or Burgundy up to 16 ounces a day. Mineral waters of all kinds. Lemonade in small quantity sweetened with saccharin.

Articles Prohibited. (Except as prescribed in the Accessory Diet.)

Sugars and sweets of every kind.
Pastry, puddings, preserves, cake and ice cream.
Bread, biscuits, toast, crackers, and griddle cakes.
Cereals such as rice, oatmeal, sago, hominy, tapioca, barley and macaroni.
Vegetables such as potatoes, carrots, parsnips, beans, peas, beets, green corn, and turnip.
Fruit. Neither fresh nor dried.
Soups, sauces or gravies thickened with flour or meal, or made with milk.
Beer, ale, porter, all sweet wines, sherry or port wine, sparkling wines, cider and liquors.
Milk, chocolate or cocoa.
Soda water and all sweet drinks.

Oatmeal Days.

Porridge made from oatmeal, 250 gm., with butter, 250 gm., salt and pepper.
Black coffee, light wine ¼ liter, or cognac, 60 c.c.
The whites of 6 eggs may be added to the porridge if desired.

	Nitrogen gm.	Carbohydrate gm.	Calories
Oatmeal	6.2	170	1025
Butter	0.4		1975
	6.6 or 42 gm. protein		3000
Alcohol (40 gm.)			210
6 whites of eggs	3.6		90
	10.2 or 63 gm. protein		3300

The entire diet consists of:—Protein, 63 gm.; nitrogen, 16.8 gm.; carbohydrate, 170 gm.; fat, 212 gm.; calories, 3300.

DIET FOR PATIENTS WITH NEPHRITIS

Occasionally patients with severe nephritis have to undergo operations; or, if they are operated on in an emergency, their post-operative care is partially one of diet. It is a known fact

that salt or sodium chloride is retained in the body in cases of kidney disease, and that its retention causes edema. Occasionally if there is a sodium chloride retention it is necessary to put the patient upon a salt-poor diet. This may be of three general varieties. The important factor in all is that the food should be prepared without any salt and that the butter and bread are to be salt-free and that no extra salt should be allowed.

Salt-Poor Diet. 1.

Breakfast

Bread, 30 gm. or 1 oz. Sugar, 10 gm. or ⅓ oz. Farina, 60 gm. or 2 oz. Butter, 30 gm. or 1 oz. 1 egg or 40 gm. or 1⅓ oz. Coffee, 150 c.c. or 5 oz.

Total, 320 gm. or 10⅔ oz.

Dinner

Bread, 30 gm. or 1 oz. Butter, 20 gm. or ⅔ oz. Sugar, 10 gm. or ⅓ oz. Rice, 60 gm. or 2 oz. Farina, 100 gm. or 3⅓ oz. Tea, 150 c.c. or 5 oz.

Total, 370 gm. or 12⅓ oz.

Supper

1 egg, 40 gm. or 1⅓ oz. Toast, 15 gm. or ½ oz. Bread, 30 gm. or 1 oz. Butter, 15 gm. or 1½ oz. Custard, 100 gm. or 3⅓ oz. Prunes, 60 gm. or 2 oz. Tea, 180 c.c. or 6 oz.

Total, 440 gm. or 14⅔ oz.

This contains chlorides, 1 gm. Protein, 35 gm. or 1⅙ oz. Fat, 65 gm. or 2⅙ oz. Carbohydrate, 140 gm. or 4⅔ oz. Calories, 1300.

Salt-Poor Diet. 2.

Breakfast

Bread, 60 gm. or 2 oz. Sugar, 40 gm. or 1⅓ oz. Farina, 60 gm. or 2 oz. Butter, 35 gm. or 1⅙ oz. 1 egg, 40 gm. or 1⅓ oz. Coffee, 150 c.c. or 5 oz.

Total, 385 gm. or 12⅚ oz.

Dinner

One egg, 40 gm. or 1⅓ oz. Bread, 60 gm. or 2 oz. Butter, 30 gm. or 1 oz. Rice, 70 gm. or 2⅓ oz. Farina, 100 gm. or 3⅓ oz. Tea, 150 c.c. or 5 oz.

Total, 450 gm. or 15 oz.

Supper

1 egg, 40 gm. or 1⅓ oz. Bread, 60 gm. or 2 oz. Butter, 30 gm. or 1 oz. Custard, 100 gm. or 3⅓ oz. Prunes, 60 gm. or 2 oz. Tea, 180 c.c. or 6 oz.

Total, 485 gm. or 15⅚ oz.

This contains chlorides, 3 gm.; protein, 50 gm. or 1⅔ oz.; fat, 100 gm. or 3⅓ oz.; carbohydrate, 240 gm. or 8 oz.; calories, 2100.

Salt-Poor Diet. 3.

This is the same as the convalescent diet without broths or soups. The fish, meat and green vegetables must be boiled in two waters to remove most of the salt. Milk, 250 c.c. or 8 oz. only allowed.

DIET IN GASTRIC CASES

The diet following stomach operations is dependent upon what has been done surgically. If the ulcer-bearing area has been removed, it is not essential to place this patient upon an elaborate gastric diet. The routine in these cases is as follows:

For the first twenty-four hours, the patient is given nothing by mouth, water being freely administered by Murphy drip. Then, water by mouth is given in dram doses every hour; and, if tolerated, after two doses, it is increased to half an ounce, alternating with peptonized milk,—one-half ounce every two hours. Thus the patient obtains something every hour. If this is well borne, after four feedings, the amount is increased to one and then to two ounces. Then easily digested substances are added, such as:

Farina, rice, sago, soft eggs; thin soups, consommé or bouillon, baked or mashed potatoes; soft vegetables such as beans, peas; buttered toast; cocoa.

After a period of two weeks or more these articles may be eaten:

Lamb or chicken in moderate amounts about two times a week; fresh fish either boiled or broiled, never fried; lettuce, water cress, romaine, endive, chicory with a good quantity of olive oil and very little vinegar; desserts, such as ice creams and custards.

It is highly important that the following foods be omitted:

Coarser vegetables such as cabbage, cucumbers, kohlrabi, tomatoes, onions, celery, corn, cauliflower, sprouts, artichokes, asparagus and beets. Also veal, pork, corned or smoked meats, lobster, crabs, shrimps, cheese excepting Philadelphia or Neuchatel, pickles, too hot or too cold drinks, strong tea or coffee, too much pastry, especially those cooked in fat, such as fritters, doughnuts; jams, cherries, cranberries and muskmelons.

Meat should be roasted or broiled; never fried.

Those cases in which the ulcerated condition of the stomach still remains because the ulcer-bearing area has not been excised are placed upon a Von Leube or Lenhartz diet. This would hold for acute perforations of the stomach and gastroenterostomies.

Von Leube Diet (Modified).—For the first three days nothing is given by mouth, but fluid is supplied by proctoclysis and a nutritive enema may be given three times daily if the patient is

asthenic. After a few days, peptonized milk ℥ ii alternating with vichy ℥ ii may be given every two hours. If this is well borne, the milk is increased one ounce daily until eight ounces are taken. If the administration of the milk is followed by no pain, the amount of vichy may be increased to four ounces. In about ten days, thickened soups, such as purée of pea, sago, tapioca and junket, are allowed. In the third week, scraped raw beef, very soft boiled eggs, macaroni, purée of vegetables, and zwieback may be given. The patient is gradually returned to a selected soft diet during the fourth week. If pain appears a return is made to the simpler milk diet.

Lenhartz Diet.—The food of a Lenhartz diet is administered at hourly intervals; it must be thoroughly masticated and eaten very slowly, and, during the treatment, the patient must be kept in bed. For the first week, the raw eggs which are used are beaten up whole and iced; the milk is also iced; granulated sugar is added to the eggs on the third day. Boiled rice, zwieback and scraped beef are prepared in the usual manner. The Lenhartz diet for fourteen days is as follows:

As eggs differ in size and weight, take the total of eggs for the day of diet, beat, measure, and divide into seven feedings and put into medicine glasses. Keep on ice and use as directed, alternating with milk. The milk is kept in a bowl of cracked ice, and the eggs are beaten up raw and iced. The spoon is kept in a bowl of ice. The feedings should be given very slowly and the patients are never allowed to help themselves.

The patient should be given small feedings frequently and fed by spoon. Salt the eggs to taste on the first and second days; sugar is started on third day.

First Day

7 a.m.	Egg
8	Milk, 20 c.c. or ⅔ oz.
9	Egg
10	Milk, 20 c.c. or ⅔ oz.
11	Egg
12 noon	Milk, 15 c.c. or ½ oz.
1 p.m.	Egg
2	Milk, 15 c.c. or ½ oz.
3	Egg
4	Milk, 15 c.c. or ½ oz.
5	Egg
6	Milk, 15 c.c. or ½ oz.
7	Egg

Total, eggs (raw), 2; milk, 100 c.c. or 3⅜ oz.

Second Day

7 a.m.	Egg.
8	Milk, 35 c.c. or 1 oz.
9	Egg
10	Milk, 35 c.c. or 1 oz.
11	Egg
12 noon	Milk, 35 c.c. or 1 oz.
1 p.m.	Egg
2	Milk, 35 c.c. or 1 oz.
3	Egg
4	Milk, 35 c.c. or 1 oz.
5	Egg
6	Milk, 35 c.c. or 1 oz.
7	Egg

Total, eggs (raw), 3; milk, 200 c.c. or 6⅔ oz.

Third Day

7 a.m.	Egg. Sugar, 2 gm. or ½ oz.
8	Milk, 50 c.c. or 1⅔ oz.
9	Egg. Sugar, 3 gm. or ¾ dr.
10	Milk, 50 c.c. or 1⅔ oz.
11	Egg. Sugar, 3 gm. or ¾ dr.
12 noon	Milk, 50 c.c. or 1⅔ oz.
1 p.m.	Egg. Sugar, 3 gm. or ¾ dr.
2	Milk, 50 c.c. or 1⅔ oz.
3	Egg. Sugar, 3 gm. or ¾ dr.
4	Milk, 50 c.c. or 1⅔ oz.
5	Egg. Sugar, 3 gm. or ¾ dr.
6	Milk, 50 c.c. or 1⅔ oz.
7	Egg. Sugar, 3 gm. or ¾ dr.

Total, eggs (raw), 4; milk, 300 c.c. or 10 oz.; sugar, 20 gm. or 5 dr.

Fourth Day

7 a.m.	Egg. Sugar, 2 gm. or ½ dr.
8	Milk, 70 c.c. or 2⅓ oz.
9	Egg. Sugar, 3 gm. or ¾ dr.
10	Milk, 70 c.c. or 2⅓ oz.
11	Egg. Sugar, 3 gm. or ¾ dr.
12 noon	Milk, 65 c.c. or 2 oz.
1 p.m.	Egg. Sugar, 3 gm. or ¾ dr.
2	Milk, 65 c.c. or 2 oz.
3	Egg. Sugar, 3 gm. or ¾ dr.
4	Milk, 65 c.c. or 2 oz.
5	Egg. Sugar, 3 gm. or ¾ dr.
6	Milk, 65 c.c. or 2 oz.
7	Egg. Sugar, 3 gm. or ¾ dr.

Total, eggs (raw), 5; milk, 400 c.c. or 13⅓ oz.; sugar, 20 gm. or 5 dr.

Fifth Day

7 a.m. Egg. Sugar, 4 gm. or 1 dr.
8 Milk, 80 c.c. or 2⅔ oz.
9 Egg. Sugar, 4 gm. or 1 dr.
10 Milk, 80 c.c. or 2⅔ oz.
11 Egg. Sugar, 4 gm. or 1 dr.
12 noon Milk, 80 c.c. or 2⅔ oz.
1 p.m. Egg. Sugar, 4 gm. or 1 dr.
2 Milk, 80 c.c. or 2⅔ oz.
3 Egg. Sugar, 4 gm. or 1 dr.
4 Milk, 80 c.c. or 2⅔ oz.
5 Egg. Sugar, 4 gm. or 1 dr.
6 Milk, 90 c.c. or 3 oz.
7 Egg. Sugar, 4 gm. or 1 dr.

Total, eggs (raw), 6; milk, 500 c.c. or 16⅔ oz.; sugar, 30 gm. or 1 oz.

Sixth Day

7 a.m. Egg. Sugar, 4 gm. or 1 dr.
8 Milk, 100 c.c. or 3⅓ oz.
9 Egg. Sugar, 4 gm. or 1 dr. Scraped beef, 12 gm. or 3 dr.
10 Milk, 100 c.c. or 3⅓ oz.
11 Egg. Sugar, 4 gm. or 1 dr.
12 noon Milk, 100 c.c. or 3⅓ oz.
1 p.m. Egg. Sugar, 4 gm. or 1 dr. Scraped beef, 12 gm. or 3 dr.
2 Milk, 100 c.c. or 3⅓ oz.
3 Egg. Sugar, 4 gm. or 1 dr.
4 Milk, 100 c.c. or 3⅓ oz.
5 Egg. Sugar, 4 gm. or 1 dr. Scraped beef, 12 gm. or 3 dr.
6 Milk, 100 c.c. or 3⅓ oz.
7 Egg. Sugar, 4 gm. or 1 dr.

Total, eggs (raw), 7; milk, 600 c.c. or 20 oz.; sugar, 30 gm. or 1 oz.; scraped beef, 36 gm. or 9 dr.

Seventh Day

7 a.m. One soft boiled egg.
8 Milk, 100 c.c. or 3⅓ oz.
9 Egg. Sugar, 13 gm. or 3 dr.
10 Milk, 100 c.c. or 3⅓ oz. Scraped beef, 23 gm. or 6 dr.
Boiled rice, 33 gm. or 1 oz.
11 One soft boiled egg.
12 noon Milk, 125 c.c. or 4 oz.
1 p.m. Egg. Sugar, 13 gm. or 3 dr.
2 Milk, 125 c.c. or 4 oz. Scraped beef, 23 gm. or 6 dr.
Boiled rice, 33 gm. or 1 oz.
3 One soft boiled egg.
4 Milk, 125 c.c. or 4 oz.
5 Egg. Sugar, 14 gm. or 3⅓ oz.
6 Milk, 125 c.c. or 4 oz. Scraped beef, 23 gm. or 6 dr.
Boiled rice, 33 gm. or 1 oz.
7 One soft boiled egg.

Total, 4 raw eggs; 4 soft boiled eggs; milk, 700 c.c. or 23⅓ oz.; sugar, 40 gm. or 1⅓ oz.; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 100 gm. or 3⅓ oz. (served with beef juice).

Eighth Day

The diet changes on this day, requiring only 4 raw eggs, which may be divided into three feedings. The other 4 eggs are to be soft boiled and given as directed by diet.

7 a.m.	One soft boiled egg.
8	Milk, 135 c.c. or 4½ oz.
9	Egg. Sugar, 13 gm. or 3 dr.
10	Milk, 133 c.c. or 4½ oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 33 gm. or 1 oz.
11	One soft boiled egg. Zwieback, 10 gm. or 2½ dr.
12 noon	Milk, 133 c.c. or 4½ oz.
1 p.m.	Egg. Sugar, 13 gm. or 3 dr.
2	Milk, 133 c.c. or 4½ oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 33 gm. or 1 oz.
3	One soft boiled egg.
4	Milk, 133 c.c. or 4½ oz.
5	Egg. Sugar, 14 gm. or 3½ dr. Zwieback, 10 gm. or 2½ oz.
6	Milk, 133 c.c. or 4½ oz. Scraped beef, 24 gm. or 6 dr. Boiled rice, 33 gm. or 1 oz.
7	One soft boiled egg.

Total, 4 raw eggs; 4 soft boiled eggs; milk, 800 c.c. or 26⅔ oz.; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 100 gm. or 3⅓ oz.; zwieback, 20 gm. or 5 dr.; sugar, 40 gm. or 1⅓ oz.

Ninth Day

7 a.m.	One soft boiled egg.
8	Milk, 150 c.c. or 5 oz.
9	Egg. Sugar, 13 gm. or 3 dr.
10	Milk, 150 c.c. or 5 oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 66 gm. or 2 oz.
11	One soft boiled egg. Zwieback, 20 gm. or 5 dr.
12 noon	Milk, 150 c.c. or 5 oz.
1 p.m.	Egg. Sugar, 13 gm. or 3 dr.
2	Milk, 150 c.c. or 5 oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 66 gm. or 2 oz.
3	One soft boiled egg. Zwieback, 20 gm. or 5 dr.
4	Milk, 150 c.c. or 5 oz. Scraped beef, 24 gm. or 6 dr. Boiled rice, 66 gm. or 2 oz.
7	One soft boiled egg.

Total, 4 raw eggs; 4 cooked eggs; milk, 900 c.c. or 30 oz.; sugar, 40 gm. or 1⅓ oz.; scraped beef, 70 gm. or 2⅓ oz.; rice, 200 gm. or 6⅔ oz.; zwieback, 40 gm. or 1⅓ oz., or toast, 20 gm. or 5 dr.

Tenth Day

7 a.m. One soft boiled egg.
8 Milk, 166 c.c. or 5½ oz.
9 Egg. Sugar, 13 gm. or 3 dr.
10 Milk, 166 c.c. or 5½ oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 66 gm. or 2 oz.
11 One soft boiled egg. Zwieback, 20 gm. or 5 dr. Butter, 4 gm. or 1 dr.
12 noon Cooked chopped chicken, 25 gm. or 6 dr. Milk, 166 c.c. or 5½ oz.
1 p.m. Egg. Sugar, 13 gm. or 3 dr.
2 Milk, 166 c.c. or 5½ oz. Scraped beef, 23 gm. or 6 dr. Boiled rice, 66 gm. or 2 oz. Butter, 4 gm. or 1 dr.
3 One soft boiled egg. Zwieback, 20 gm. or 5 dr. Butter, 4 gm. or 1 dr.
4 Cooked chopped chicken, 25 gm. or 6 dr.
5 Egg. Sugar, 14 gm. or 3½ dr.
6 Milk, 166 c.c. or 5½ oz. Scraped beef, 24 gm. or 6 dr. Boiled rice, 67 gm. or 2 oz. Butter, 4 gm. or 1 dr.
7 One soft boiled egg.

Total, 4 raw eggs; 4 cooked eggs; milk, 1000 c.c. or 33⅓ oz.; sugar, 40 gm. or 1⅓ oz.; scraped beef, 70 gm. or 2⅓ oz., boiled rice, 200 gm. or 6⅔ oz.; zwieback, 40 gm. or 1⅓ oz.; or toast, 20 gm. or 5 dr.; chicken, 50 gm. or 1⅔ oz.; butter, 20 gm. or 5 dr.

Eleventh Day

7 a.m. One soft boiled egg. Milk, 250 c.c. or 8⅓ oz.; zwieback, 10 gm. or 2½ dr. Butter, 4 gm. or 1 dr.
9 Egg. Sugar, 13 gm. or 3 dr. Scraped beef, 20 gm. or 5 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.
11 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Butter, 6 gm. or 1½ dr. Zwieback, 10 gm. or 2½ dr.
1 p.m. Egg. Sugar, 15 gm. or 3 dr. Cooked chopped chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz.
3 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Scraped beef, 20 gm. or 5 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.
5 Egg. Sugar, 14 gm. or 3½ dr. Cooked chopped chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz. Butter, 6 gm. or 1½ dr.
7 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr. Scraped beef, 30 gm. or 1 oz.

Total, 4 raw eggs; 4 cooked eggs; milk, 1000 c.c. or 33⅓ oz.; butter, 40 gm. or 1⅓ oz.; sugar, 40 gm. or 1⅓ oz.; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 300 gm. or 30 oz.; zwieback, 60 gm. or 2 oz.; chicken, 50 gm. or 1⅔ oz.

Twelfth Day

7 a.m. One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Zwieback, 10 gm. or 2½ dr. Butter, 4 gm. or 1 dr.

9 Egg. Sugar, 13 gm. or 3 dr. Scraped beef, 35 gm. or 1 oz. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

11 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Zwieback, 20 gm. or 5 dr. Butter, 6 gm. or 1½ dr.

1 p.m. Egg. Sugar, 13 gm. or 3 dr. Cooked chopped chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

3 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Scraped beef, 35 gm. or 1 oz. Boiled rice, 50 gm. or 1⅔ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

5 Egg. Sugar, 14 gm. or 3½ dr. Chopped cooked chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

7 One soft boiled egg. Milk, 250 c.c. or 8⅓ oz. Zwieback, 10 gm. or 2½ dr.

Total, 4 raw eggs; 4 cooked eggs; milk, 1000 c.c. or 33⅓ oz.; sugar, 40 gm. or 1⅓ oz; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 300 gm. or 10 oz.; zwieback, 80 gm. or 2⅔ oz.; chicken, 50 gm. or 1⅔ oz.; butter, 40 gm. or 1½ oz.

Thirteenth Day

7 a.m. One soft boiled egg. Milk, 142 c.c. or 4⅔ oz. Zwieback, 10 gm. or 2½ dr. Butter, 4 gm. or 1 dr.

9 Egg. Sugar, 13 gm. or 3 dr. Milk, 142 c.c. or 4⅔ oz. Scraped beef, 20 gm. or 5 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 20 gm. or 5 dr. Butter, 6 gm. or 1½ dr.

11 One soft boiled egg. Milk, 144 c.c. or 5 oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

1 p.m. Egg. Sugar, 13 gm. or 3 dr. Milk, 142 c.c. or 4⅔ oz. Cooked chopped chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or ½ dr.

3 One soft boiled egg. Milk, 144 c.c. or 5 oz. Scraped beef, 20 gm. or 5 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

5 Egg. Sugar, 14 gm. or 3¼ dr. Milk, 142 c.c. or 4⅔ oz. Cooked chopped chicken, 25 gm. or 6 dr. Boiled rice, 75 gm. or 2½ oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

7 One soft boiled egg. Milk, 144 c.c. or 5 oz. Zwieback, 10 gm. or 2½ dr. Butter, 6 gm. or 1½ dr.

Total, 4 raw eggs; 4 cooked eggs; milk, 1000 c.c. or 33⅓ oz.; sugar, 40 gm. or 1⅓ oz; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 300 gm. or 10 oz.; zwieback, 80 gm. or 2⅔ oz.; chicken, 50 gm. or 1⅔ oz.; butter, 40 gm. or 1⅓ oz.

Fourteenth Day

7 a.m. One soft boiled egg. Minced chop. Buttered toast. Milk, 142 c.c. or 4⅔ oz.

9 Boiled rice. Buttered zwieback. Custard. Milk, 142 c.c. or 4⅔ oz.

11 One soft boiled egg. Buttered zwieback. Junket. Milk, 142 c.c. or 4⅔ oz.

1 p.m. Minced chicken. Boiled rice. Buttered zwieback. Custard. Milk, 142 c.c. or 4⅔ oz.

3 One soft boiled egg. Cooked scraped beef. Boiled rice. Buttered toast. Milk, 144 c.c. or 5 oz.

5 Minced chicken. Boiled rice. Buttered zwieback. Custard. Milk, 142 c.c. or 4⅔ oz.

7 One soft boiled egg. Buttered toast. Milk, 144 c.c. or 5 oz.

Total, 4 raw eggs; 4 cooked eggs; milk, 1000 c.c. or 33⅓ oz.; sugar, 4 gm. or 1⅓ oz.; scraped beef, 70 gm. or 2⅓ oz.; boiled rice, 300 gm. or 10 oz.; zwieback, 100 gm. or 3⅓ oz.; butter, 40 gm. or 1⅓ oz.; chicken, 50 gm. or 1⅔ oz.

ANTI-CONSTIPATION DIET

Most people after operation are very constipated. Constipation has very serious sequelae and the importance of impressing upon the patient's mind the necessity of a daily movement of the bowels cannot be overemphasized. There should be a regular time for moving the bowels, which should be observed conscientiously. The best time is shortly after breakfast; the patient should remain seated on the toilet for at least five or ten minutes, and then if there is no desire to move the bowels, a glycerine suppository should be inserted to stimulate the movement. Provided there is no contraindication to any of the coarser vegetables, the patient should be placed upon the anti-constipation diet.

Breakfast

Any fruit, fresh, cooked, preserved, or dried.

Shredded wheat, Thomas uncooked wheat biscuit, or oatmeal, or toasted corn flakes with cream if possible, otherwise a small amount of milk and sugar or molasses.

Bread.—Use only graham, rye, bran, whole wheat or corn bread.

Butter, jam, jelly, or honey. Coffee with cream and sugar.

Luncheon and Dinner

Soup.—Any kind except those thickened with flour, or containing milk.

Fish, meat, or eggs in moderation. Eat as much of the fat as possible.

Vegetables.—Fresh or canned in any quantities. Green salads with olive oil.

Desserts.—Fresh fruit or fruit cooked or preserved is best; also jellies prepared with coffee, wine and lemon, etc. Water ices may be eaten freely but only small amounts of ice cream may be taken. The undercrusts of pies may not be eaten.

General Directions.—Take at least a glass of water before breakfast, one in the middle of the day, and one at night. In addition take as much water as may be desired. This may be plain water, vichy or any carbonated water. Buttermilk, sour milk, cider, beer, and white wine are allowed. Butter in any quantity is permitted.

Avoid tea, red wine, milk and whisky, white bread, noodles, vermicelli, macaroni, cake, rice, barley, potatoes, and cheese.

General Rules.—Have a regular time for going to the toilet. Take a daily walk in the open air. Practice the setting-up exercises daily.

Setting-up Exercises.

1. Knees stiff; bend forward and try to touch floor with fingers.
2. Bend body backward from hips.
3. Bend body to the right and left from hips.
4. Rotate to the right and to the left on hips.

ANTI-OBESITY DIET

Very often it is necessary to reduce extremely stout individuals before any operation is undertaken. Of course, this is difficult to accomplish and great care and judgment should be exercised because the patient must not be weakened unnecessarily. The general routine is as follows:

1. A hot bath on Monday, Wednesday, and Friday for ten minutes before retiring.
2. Epsom salts, one tablespoonful in cold water on Tuesday morning.
3. Walk at least one mile daily.
4. Setting-up exercises for ten minutes each morning before breakfast.

Breakfast	Calories	Proteins
One orange or one apple	70	1
Coffee with 4 tablespoonfuls milk	20	2
1 teaspoonful sugar	20	0
2 eggs or lean meat (about 5 x 3 x ½ inches)	150	13

Luncheon		
Cup of beef tea or clear soup	25	3
Tea with 2 tablespoonfuls milk	20	1
1 level teaspoonful sugar	15	0
2 slices of bread about 4 x 4 x ½ inches	146	4½
1 pat of butter about 1 x 1 x ½ inches	80	
1 saucerful spinach, celery, or green vegetable	5	
Lean meat about 5 x 3½ inches	300	24
Dinner		
One cup of beef tea or clear soup	25	3
Tea with 2 tablespoonfuls of milk	20	1
1 teaspoonful sugar	15	2¼
1 slice of bread	70	2¼
Butter, one-half pat	40	
Meat about 5 x 3 x ½ inches	300	24
Entire potato or 2 tablespoonfuls of any starchy vegetable without grease	90	2
Total	1405	80¾
Additional Diet if prescribed:		
One quart of buttermilk	640	60
American cheese, one inch cube	70	40

NUTRIENT ENEMATA

As a rule these enemata are not very successful, but when food is constantly vomited from the stomach, or when there is a stenosis of the cardia of the stomach or esophagus, at least some little nourishment is received in this way. Preceding it a cleansing enema of about one pint of normal saline solution should be given. It is advisable to use a small soft tube and to insert it about 25 cm. from the rectum, for the higher it is introduced the greater is the absorption.

The food used in the enema is thoroughly mixed, then strained through cheese cloth, and poured into the funnel, five ounces at a time, at a temperature of 110° F. Great care should be taken that no air is introduced. The patient must lie quietly in bed for at least twenty minutes after the enema. Following are several formulae which may be used:

1. The whites of two eggs and peptonized milk, 90 c.c.
2. One whole egg, 1 gm. of salt, 10 c.c. of brandy, 90 c.c. of peptonized milk.
3. Boas's formula.—250 c.c. milk, yolks of two eggs, 3 gm. table salt, 1 tablespoonful red wine, 1 teaspoonful wheat starch.

Feeding through Fistula.—This is employed when an opening has been made in the stomach because of some benign or malignant disease of the esophagus or cardia of the stomach, or a fistula has been established in the jejunum. The food which is passed through the fistula must be either fluid or semi-solid and properly warmed.

CHAPTER XIV

ANESTHESIA

I. GENERAL

PREPARATION OF THE PATIENT

The first thing to learn about the preparation of a patient for an anesthetic is that it is very important in both its immediate and its more remote consequences. It does not need to be explained, of course, that this applies to the various nursing treatments such as the regulation of diets, medications, etc., but the point which is often overlooked by the inexperienced is that the state of mind in which a patient approaches his anesthetic will determine very materially the way in which he will undergo the period of anesthesia, and that this in turn will have a vital effect upon his endurance of the operation and his recovery from the effects of both the operation and the anesthetic.

The preparation, therefore, should begin with the patient's mind, and at no time throughout the items of the physical preparation should the nurse forget this important *mental involvement* in her work. There is always a great element of fear in the anticipation of taking an anesthetic, of surrendering consciousness, and of submitting to surgery, and there is perhaps no condition which the anesthetist dreads more in his subject than that of nervous apprehension, for as a rule an agitated or hysterical state of mind will reflect itself in the physical reactions to the anesthetic and will nearly always persist throughout the operation and the recovery from the anesthetic. The muscles of the body in such subjects will be tense and this will entail shallow and irregular respirations and consequently slow and irregular absorption of the anesthetic. Crying will do the same and in addition will cause detrimental obstruction of the air passages by tears, mucus, and congestion. Conscious resistance by these patients will pass over into unconscious struggling as the anesthesia develops, and will prolong and complicate it in

numerous ways. And finally, all these irregularities will use up valuable vitality and preclude the best anesthesia and recovery. This state of affairs the nurse can prevent entirely in some cases and to a great degree in most cases by judicious word and deed as she goes about the preparation. This merely means that her general attitude will be reassuring and encouraging, and that she will avoid as far as possible all reminders of the event for which she is preparing. Such conduct has, of course, been dinned into every nurse's ears continuously ever since she entered the hospital as the only kind which ever befits a nurse, but she must practice it in this case with the utmost degree of refinement.

With this lesson well in hand *the bodily preparation* of the patient may be taken up. There will be specific orders by the surgeon, and these will vary in detail; and there will also be variations depending upon the anesthetic to be given, the nature of the operation, and the length of time which is to intervene between the preparation and the operation. Moreover, in cases of accident and other emergency there may be no preparation outside of the operating room. Nevertheless, though we can cover this ground in only a somewhat general way, we shall enumerate the probable steps as follows:

1. A *cathartic* may be administered twelve or more hours before the operation. There is just as much likelihood, however, that a cathartic will not be given because some surgeons omit it in the belief that it contributes a measure of metabolic disturbance to recovery. Also, the mere fact that emergency cases, in which there has been no time for this treatment, make comparatively satisfactory recoveries is convincing that this preliminary purgation has no advantages which overbalance its disadvantages.

2. Six hours or more in advance *food will be prohibited* or perhaps restricted to fluids till two or three hours before the appointed time for the operation, and then nothing will be administered by mouth. It is obligatory that several hours of starvation immediately precede an anesthetic because anything in the stomach, even water, is likely to cause vomiting when the anesthetic begins to take effect, and this, besides being annoying, may have serious asphyxial results. In some cases the question of harmful prostration from lack of food may override the danger of its presence in the stomach, but care must be

exercised in this event to give foods which the stomach will dispose of most rapidly such as broths, tea or coffee, etc.; and milk should be especially avoided for this reason, even in the tea and coffee. Since the starvation, like purgation, is held responsible for metabolic disturbances, some surgeons will give those patients who are not overweight a special carbohydrate diet for several days in advance of the starvation period with a view to providing a fuel reserve to tide over this period. In this diet will probably be included such foods as lactose, glucose, candy, malted milk, etc., and as a factor in the treatment emphasis will probably be placed upon the administration of fluids in abundance.

3. The operative field may be prepared at any time, but this will usually be determined by order and by circumstances.

4. Several hours in advance one or more cleansing *enemas* will be given. This part of the preparation must be done with considerable caution because it must be remembered that if the patient has been subjected to vigorous catharsis it may have been exhausting; that the tonic effect of food has been curtailed; and that in any case an enema is liable to be prostrating. Nervous patients, and those in a state of reduced general vitality may entirely collapse under the administration of the enema at this time if care is not exercised. Plenty of time should be reserved for this treatment and all suggestion of haste should be avoided.

5. In cases of intestinal obstruction, other cases where the stomach is not empty, or where an operation is to be performed upon the stomach, a *lavage* may be given. This is another treatment which calls for extreme calmness because it is always a trying and exhausting ordeal for the patient and those needing it will usually be in poor condition.

6. Immediately before the anesthetic is administered *the bladder must be emptied*, and by catheterization if necessary.

7. The patient is clad in loose, simple *clothing*, and plenty of it, according to the season. As a rule, a nightgown reinforced over the chest with a piece of flannel, loosely-fitting stockings, and a suitable number of blankets will comprise the wearing apparel.

8. *False teeth*, including removable bridge work, will be removed and carefully laid away.

9. All *jewelry* is removed and safely cared for also. In cases

where there may be sentiment on the part of the patient against removing some article of jewelry, such as a ring, it should be secured against loss by being tied in place with a piece of tape or bandage.

10. *When the anesthetic is to be administered rectally* there will probably be a special course of preparation ordered and the details of this will vary with the surgeon and the anesthetist, but, in general, there will probably be more attention directed toward the emptying of the alimentary canal in this case than in the more usual cases where the anesthetic is to be inhaled. In addition to catharsis, starvation, and enemas there may also be a rectal irrigation; a general sedative, probably morphine, will be administered an hour or so in advance of the anesthesia; there may be a preliminary injection of a small amount of ether in olive oil several hours in advance; and sometimes a sedative suppository may be ordered. The nurse will remember, of course, that rectal (sometimes called "colonic") anesthesia is general anesthesia and that it calls, therefore, for the same general precautions during the preparation as do the other cases. In particular, it is even more important that the rectal anesthesia cases be kept calm and peaceful because if they are not so they may not be able to retain the anesthetic when injected. If you have given a dose of morphine, a sedative suppository, etc., you will naturally nurse your patient in such a way as to make your drugs effective.

CARE OF PATIENT DURING ANESTHESIA

The policy of calmness and reassurance which you adopted before beginning the preparation must be observed with redoubled effort when the administration of the anesthetic is begun, because, as pointed out above, *the mental attitude of the patient* will determine his behavior in general throughout his anesthesia. Absolute quiet in the room will be necessary for the best results, and talking or whispering, especially after the administration of the anesthetic has been begun, are particularly objectionable because the sense of hearing is one of the last to be anesthetized and as it often functions capriciously at this time patients may get undesirable impressions from what is said. Furthermore, conversation often leads partially anesthetized patients to make efforts to partici-

pate in it and this will delay the anesthesia and aggravate the excitement. Also, too great caution cannot be exercised in deciding when the sense of hearing has been entirely overcome and when it will be safe to indulge in professional discussion of the patient's condition which it might not be wise to let him hear.

There will usually be some degree of *struggling*, sometimes voluntary and nearly always involuntary, during the induction of the anesthesia, particularly in the case of ether, and the nurse will usually be expected to do guard duty against it.

The arms and legs will be her chief concern, for though sometimes a strong patient will endeavor to sit up and even thrust himself from the table, if the arms and legs are kept in place he is helpless further. It is sometimes the custom to restrain the legs by binding them to the table with a strong strap passed just above the knees. With a strong, healthy patient, which is the type most likely to cause trouble, this precaution may be necessary, especially if there are not enough assistants available to control him, for one assistant cannot manage such a subject; but this practice will be very exciting to some patients and should not be adopted unless absolutely necessary. For these excitable patients a good plan will be to have this strap ready and to defer the adjustment of it till a degree of unconsciousness has been attained; or, some subjects will not be alarmed by this restraint if it is explained that you are applying it to prevent them from rolling from the narrow table after they have gone to sleep. In fact, this apology for the strap, if sincerely made, will sometimes comfort a nervous patient and give him a sense of security, though one always runs a risk when undertaking this plan.

In some institutions it is the practice to bind the arms, shoulders, and legs to the table with a few turns of a strong bandage, and the anesthetist is then able to proceed alone, but it will be a rare patient who will not suffer more or less under such treatment and it seems that urgent necessity is the only justification for it.

Whatever plan may be adopted for guarding the legs, the attendant nurse's duty will be to care for the hands. Most patients are reassured by having their hands supported gently by another person at this time because they realize, of course, that they will soon be unconscious, and many have expressed appre-

hension of danger befalling their hands. With strong patients who may be expected to be exceptionally hard to control, it will be best to ask them to place their hands comfortably upon the table at their sides and to turn the palms downward; the nurse can place a hand gently upon each of his wrists (standing with face toward the anesthetist) and thus be prepared for the worst, for pressure upon the wrists can prevent the patient from turning his palms from the table and unless he can turn his hand he cannot rise. This will be an unnecessary precaution, however, for the average patient, and the nurse's rule should be to advise him to put his hands where they are most comfortable and then, in a natural way, to place her own hands upon his wrists or forearms in such a way as to be prepared to foil any sudden attempt upon his part to do the instinctive thing of grabbing the inhaler.

The nurse responsible for the hands should *form the habit of following the pulse*. Anesthetists will do this for themselves but there are times when they are so entirely occupied otherwise that many of them will be grateful for this assistance. In performing this service the nurse must know what variations to expect under the several anesthetics, and these we shall indicate below as we discuss some of the reactions of patients to the more common anesthetics.

Care should always be taken not to hold the hand of a patient in such a way that he may grip it, for a strong one may entirely overcome a nurse in this way when in the stage of excitement and he may even injure her.

The foregoing comments will apply in a general way to subjects of all anesthesia, but as your specific troubles and duties will depend somewhat upon which of the several anesthetics is used we shall take up separately each one of the five more common ones: Nitrous oxide, ethylene, ether, chloroform, and ethyl chloride, and point out briefly the usual behavior of patients under them and the corresponding nursing care.

Nitrous Oxide.—The induction period of this anesthetic is very short, lasting only a few seconds and there will be little or no struggling, so the nurse's duties will not extend much beyond assisting the anesthetist in keeping the patient composed so that he will breathe deeply and regularly. The general precautions against excitability outlined above, however, should always be taken, as occasionally they will be helpful.

With nitrous oxide *the pulse* should not show much change, but should be regular, full and quiet.

Ethylene.—The induction period for ethylene will follow a course *similar to that of nitrous oxide.* There will probably be little pronounced struggling but the nurse should be prepared to control moderate movements of the arms and legs.

The pulse is probably not much affected by ethylene but it should be followed in this case, as in all others, because the factors of nervous excitability and idiosyncrasy should always be kept in mind.

Since *ethylene is highly explosive* the operating room nurse has an additional responsibility, when it is being used, of seeing that there is in the room no source of ignition for this anesthetic. The anesthetist will take the precaution of grounding his apparatus or of manipulating it in such a way as to avoid the common frictional discharge, but the nurse must remember to bar from the room such things as the cautery, gas flame, lighted match, X-ray apparatus, a sparking motor, etc.

Ether.—This anesthetic calls for all the precautions mentioned above (except those as to the explosiveness of ethylene) because its induction period is relatively long, the anesthetic is comparatively disagreeable to take, there is almost always *a period of excitement* of greater or less duration and severity, and there are numerous respiratory and other irregularities which may arise and call for a helping hand from the nurse.

The anesthetist will, of course, guide the nurse's general course of action, but unless otherwise instructed she will make no mistake by following the more moderate course we have already advised. On the subject of *restraint* during the stage of excitement in the induction of ether anesthesia anesthetists will disagree. Some will prefer absolute resistance from the beginning to all efforts on the part of the patient, especially with his hands, and others will act upon the belief that early resistance to these efforts only aggravates them and will therefore advise permitting any activity that does not displace the inhaler or allow the patient to harm himself or the attendants. Personally, we have been entirely converted to this latter practice and are therefore inclined to advise the nurse to adopt it where she is not otherwise directed by the anesthetist, but she must be very sure beforehand that she is prepared to carry it out successfully, and

must remember that even though the plan may succeed at first, some cases will later compel her to abandon it for the sterner measures.

With ether one expects *the pulse* to increase more or less in force and frequency, but extreme or sudden increase in frequency and other abnormal developments in the pulse will be matters of concern.

Chloroform.—The induction of chloroform anesthesia is usually less eventful from the nurse's standpoint than that of ether, that is, cases of extreme *excitement* will not be so numerous; but they will occur and must therefore be kept in mind. There is one important difference between the two anesthetics which the nurse should note, and that is that ether is, in general, stimulating to the action of the heart in the early period of its administration while chloroform is depressing. For this reason patients to whom chloroform is being administered should not be allowed the extreme activity during the stage of excitement which we have advised for those receiving ether. The anesthetist will control this, but we owe it to the nurse here to emphasize the fact that the method we recommended so highly for ether patients must be confined to them.

The pulse of the chloroform patient is of comparative importance. We have just remarked that chloroform depresses the heart, and so it does, but the nurse watching the pulse will notice that in the very beginning of the administration there may be a slight quickening of the pulse and a noticeable increase in its force. Very soon, however, there will be a gradual decrease of both which will probably extend below the level you noticed before the anesthetic was started. Extremes in either direction are, of course, danger signals.

Ethyl Chloride.—Ethyl chloride is not in general use for prolonged anesthesia, but it is popular in some communities for *short operations and dressings* which require only a few moments. We mention it here since its administration will usually require the attendance of a nurse throughout because entire relaxation is rarely attained and restraint of hands or the part operated upon will usually be necessary. Induction, entire anesthesia, and recovery will all take place within a few moments, and as *vomiting* often occurs very soon after the with-

drawal of the inhaler, the nurse should be prepared for this from the beginning.

With ethyl chloride *the pulse* should not show much change, as a rule, except perhaps a slight decrease of frequency and force.

During the operation the anesthetist will be responsible for observing the general condition of the patient, but the operating room nurse also should make it a rule to remember the patient's condition and to be prepared to supply warm blankets, hot water bottles, hypodermics, etc., at any time. The temperature of the room is also the nurse's responsibility, and she should remember that maintenance of the standard temperature (75°-76° F.) and the exclusion of draughts have a direct influence in conserving the patient's well-being.

AFTER CARE

After the operation the nurse will usually be left entirely responsible for the preparation of the patient for the journey to his bed, and she will see that he is *well wrapped in blankets*. During anesthesia, especially with ether, there may be considerable perspiration, and as the outer hallways through which the patient is carried will doubtless be cooler than the operating room and well supplied with draughts, it will be very easy for him to become suddenly chilled and thus to contract bronchitis or pneumonia. Also, ether patients have been given a predisposition to these two complications by the irritant effect of ether upon the air passages. In any other case, no matter what the anesthetic has been, it must be remembered that the patient's vitality has been lowered by both it and the operation itself and that he must be as well fortified as possible against the effects of sudden change of temperature.

Special care must be taken also in *handling an anesthetized patient*, for violent or sudden change of position may seriously interfere with cardiac or respiratory action either directly by overtaxation or indirectly by inducing vomiting and consequent choking, etc. Often, when ether or chloroform anesthesia has been profound, the patient may be transferred to his bed with-

out arousing him to any degree if he is handled gently and quietly. A good *method of lifting patients* carefully and easily is illustrated in Fig. 39.

The *bed* should have been previously warmed with hot water bottles, a warm blanket should be placed directly underneath the patient and plenty of warm ones over him—that is, there are no

FIG. 39.—AN EASY AND SAFE METHOD OF LIFTING A HELPLESS PATIENT. The two nurses at the sides of the table are grasping a piece of heavy canvas, about 1 yard long and ½ yard wide, which lies across the table under the patient's hips.

intervening sheets. His *bedroom* should be well heated, draughts prevented, and the temperature of his body, particularly the hands and feet, observed from time to time by feeling them. In warm weather, or when the patient is in good general health and the anesthesia has been slight or short (as in short administrations of nitrous oxide, ethylene, or ethyl chloride) the blankets

and some of the other precautionary measures may not be necessary, but the patient should, of course, be given the benefit of any doubt.

Though events of recovery will depend somewhat upon the temperament and physical condition of the patient, there is a general course which may be expected for each of the anesthetics and certain accidents and complications which are peculiar to each. We shall, therefore, discuss separately the recovery to be expected from each of the five anesthetics. It must be remembered, however, in all cases that the nature of the operation modifies recovery to a greater or lesser degree, but your study of shock, hemorrhage, and other operative and post-operative complications will teach you to make the necessary differentiations.

Nitrous Oxide.—Patients who have had this gas will recover within a very few minutes, as a rule, though the time will often be prolonged by *hysterical outbursts* of laughing, crying, etc. *Nausea and vomiting* sometimes occur, but they are infrequent. Oftenest a patient will show signs of lassitude and may sleep for a considerable time, especially if a sedative has been given before the operation. *Headache* is not uncommon and may sometimes be very persistent. The *pulse and respirations* of these patients should always be watched closely for some time, but as a rule recovery will be uneventful in these respects.

Nitrous oxide subjects will usually be able to take *nourishment* comparatively soon after recovery, but the surgeon's order will determine the nurse's course in this respect as there will often be surgical reasons of which the nurse may not know which will control administrations by mouth. Comments on page 233 on the administration of water to ether patients will apply, in general, to nitrous oxide subjects.

Ethylene.—Recovery from ethylene is very rapid, as a rule, requiring only a few minutes. However, if considerable morphine has been given to the patient it may prolong the recovery. There will be *nausea and vomiting* in some cases but they will not frequently last long and are not likely to be severe. The *pulse and respiration* after ethylene will usually follow an uneventful course, but these cardinal symptoms will, of course, be followed carefully after any operation regardless of the anesthetic, and the nurse should always keep in mind the probability that mor-

phine or some other sedative has been given in cases of gas administration.

The administration of *water and nourishment* after ethylene will correspond closely with that for nitrous oxide. However, since ethylene does not cause undue perspiration, these patients will probably not be excessively thirsty.

Ether.—Recovery from this anesthetic calls for careful nursing, and patients should not be left alone for one moment until consciousness is established, for whatever aid they may need during this time must be given promptly.

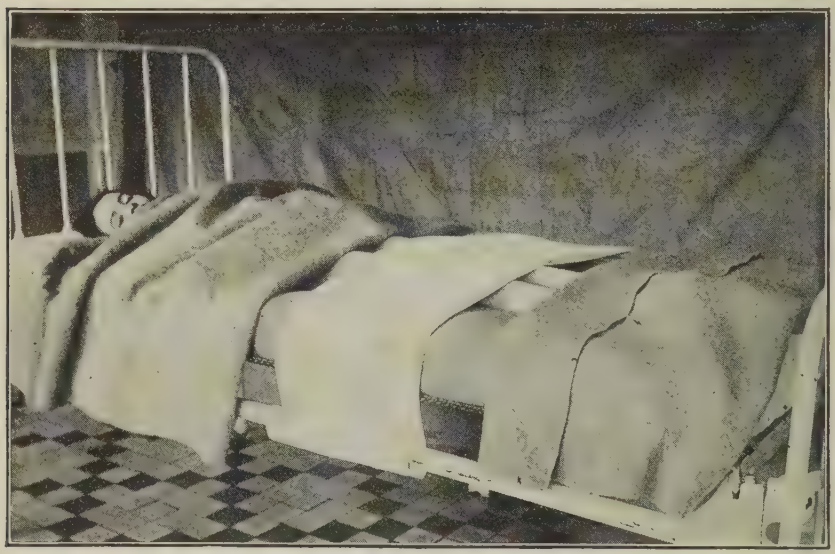


FIG. 40.—RESTRAINING SHEET FOR PATIENTS RECOVERING FROM AN ANESTHETIC. Strong safety pins may keep this in place on the bed frame; if the bar to which it is attached is not cylindrical, friction will hold a tightly drawn and well tucked in sheet; or, the sheet may be passed entirely around the bed springs and the ends fastened together underneath.

Provision should be made early for the *restraint* of violence during recovery, for all the efforts incident to the stage of excitability in the induction of the anesthesia may be repeated during recovery. The favorite attempt of these patients is to get out of bed, and if there are not enough assistants to control them through the period of this tendency a restraining sheet should be fastened across the bed just above the knees (Fig. 40). This will be of enough assistance, as a rule, so that one nurse can master the situation.

The *respirations* should be watched closely, for there are many respiratory complications which may arise before consciousness is regained. Regularly, the patient recovering from ether will breathe less deeply and vigorously than normally because, though ether acts as a stimulant early in its administration, it eventually tends to depress the respiratory nerve center. The color of the face, particularly of the ears and lips, will be a good guide as to whether or not he is inhaling sufficient oxygen if it is not convenient to observe his chest motion. In this connection the nurse should remember that sedatives, especially morphine, if given recently, will probably have contributed to the depression and she will make allowance on that basis for abnormally slow or shallow respirations, but she should not be too slow to be alarmed by respiratory depression after an anesthetic. In cases of extreme or sudden depression, while waiting for help, vigorous rubbing of the lips and face with a coarse towel may revive the patient somewhat, and of course the nurse is always prepared to give artificial respiration in cases of emergency. However, if the color and pulse are good and the patient is breathing unobstructedly the best treatment is to leave him alone, for many will pass unconsciously from their anesthesia into a sound sleep from which they will awaken in an hour or two fully recovered and more comfortable for thus having passed away time which would otherwise have been very unpleasant. This last remark has been inspired by observation of occasional instances in which concern has been felt for the patient who quietly "slept off" his anesthetic, and he has been aroused with no other effect than to bring him into earlier consciousness of his troubles than necessary.

Other respiratory complications may arise early through *occlusion of the pharynx* by a swollen or flabby tongue or by accumulation of mucus or vomitus. This can usually be avoided by keeping the patient's head turned to one side during recovery, or, if possible, by turning his entire body toward one side, both of which measures allow any fluid to run out of the mouth and also tend to throw the tongue and jaw forward and away from the posterior wall of the pharynx. In cases of persistent tendency of the tongue to occlude the throat the simple pushing forward of the jaw may overcome the difficulty as this carries the tongue forward also. This is often hard for the young nurse to learn

to do properly, but if she will first make sure that the teeth are not locked together and will then thrust the lower teeth in front of the upper ones, or as nearly so as possible, she will accomplish all that she can by this measure. Sometimes, however, it may be necessary to reach into the mouth with a pair of tongue forceps (Fig. 41), or the fingers covered with a towel or piece of gauze, and pull the tongue forward and swab out the mucus with a sponge on a holder. For this it will be necessary to hold the mouth open with a gag of some kind (Fig. 42) so as to prevent

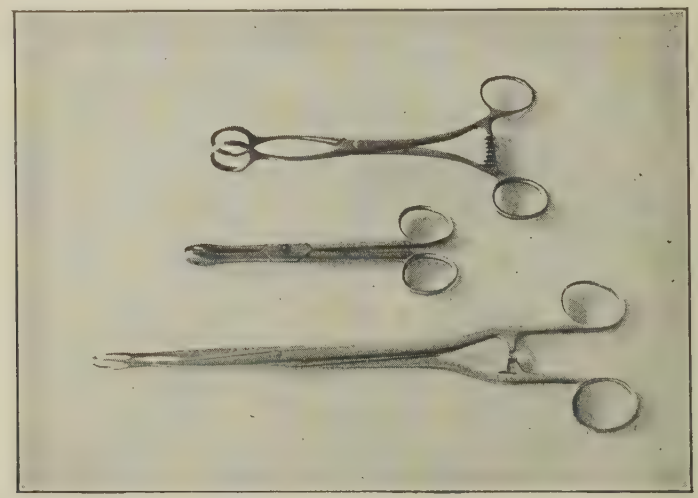


FIG. 41.—SUITABLE INSTRUMENTS FOR GRASPING THE TONGUE. The two having locks are the more useful because they answer also as sponge holders for swabbing out the throat, but when used for grasping the tongue care must be taken not to lock them so tightly as to crush it.

biting of the fingers, the tongue, or the forceps. Occasionally a spasm of the jaw will accompany this condition and the patient will become very cyanotic. This calls for vigorous and quick action in prying the mouth open with a mouth gag and relieving the obstruction as just described. In doing this great care must be taken, of course, not to injure the teeth.

Nausea and vomiting will occur in an average of 50 per cent. of the ether cases. Some anesthetists show lower percentages than this, but half the cases will be a fair number to count upon. This should not persist for more than a few hours, though patients naturally subject to digestive disorders may be thus

annoyed much longer. Special care must be exercised with the patient when vomiting as there is always danger of his inhaling the vomitus and becoming asphyxiated by it; and it is also possible that inhaled vomitus is responsible for some cases of "ether pneumonia." Also, his eyes must be shielded from the vomitus as they may be considerably irritated by it and develop a troublesome and painful case of conjunctivitis. When consciousness has been recovered to some degree the coughing reflex will function and the patient will be able to save himself from the asphyxial danger by coughing, but in any case his head should

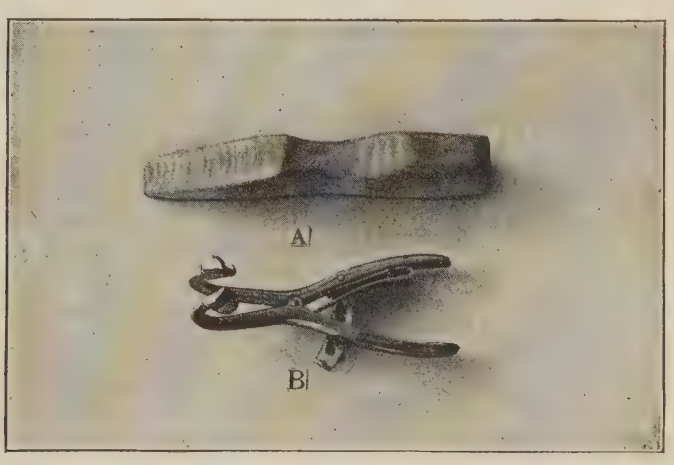


FIG. 42.—MOUTH GAGS. *A*, a simple wooden wedge which is very safe and very serviceable for prying the teeth apart, as well as for holding the mouth open temporarily for swabbing, pulling the tongue forward, etc.; *B*, metal gag which can be inserted only after the teeth have been well parted, but which is self-retaining when well placed.

be held to one side while vomiting and the mouth swabbed clean if necessary. The character of the vomitus should always be noted. In ether cases there is likely to be much mucus, as ether stimulates all secretions more than the other anesthetics; and there will be indications of bile sometimes, and of stomach secretions. If blood is present it will be a matter of special concern. However, if the operation has been upon some part of the mouth, nose, throat, or stomach, it must be expected that old blood ("coffee grounds") which has been spilled or swallowed will be vomited. Bright red blood is alarming also, but a bitten tongue or a loosened tooth may be the contributing agent of this.

Any case of unusual vomitus, however, should be reported to the surgeon as it will usually call for investigation by him.

The pulse, of course, is watched closely. That, too, will be somewhat depressed, at least for a short time after the patient's return to bed, but within an hour or so it should show signs of recuperation.

There are several odd manifestations which may accompany recovery from ether, such as *tremor, hiccough*, etc., but they are usually transitory and are not seriously significant unless they persist unduly. It is very likely that the patient who has manifested the tremor during the induction of his anesthesia will do so again when he recovers, but the nurse must not make the mistake of overlooking a real chill in these patients because the two conditions are easily confounded and a chill, as every nurse knows, is not to be taken lightly. Likewise, persistent hiccough should be regarded seriously because, aside from being very distressing to the patient, it may signify something deeper than a mere irregularity of recovery of consciousness.

Pulmonary edema is another complication of ether anesthesia, though it is an infrequent one. The nurse has doubtless learned elsewhere the symptoms of edema of the lungs and will at once recognize the unmistakable sound caused by the great quantity of mucus which has accumulated in the lungs and is being "washed" back and forth with respirations. A collection of thick mucus in the throat will sometimes cause a similar sound and even a degree of the cyanosis so prominent in edema, but swabbing of the throat and observations of the patient's general condition will quickly tell the nurse whether or not to be alarmed.

Another complication to be feared and guarded against is *"ether pneumonia."* It is not frequent, but the nurse must always bear it in mind. General nursing training will have taught the nurse the warning signs and symptoms of pneumonia, so we shall not take space for them here.

Some authorities attribute one or two *kidney disorders* to ether, chiefly that of albuminuria and sometimes suppression. Urinalysis will show that albuminuria often does arise after anesthesia; but whether it is caused by the anesthetic or by something else will not concern us here as its treatment, if there is any, will be by prescription only. Suppression, of course, would be a serious condition but it is a nursing problem here

only in so far as the nurse will be responsible for reporting as to whether or not evacuations of the bladder occur normally.

The *voiding of urine* is always a matter of attention after anesthesia and if it does not occur normally, or nearly so, it must be regarded with concern. This may be due to suppression, which may or may not have reference to the anesthetic; but it will be very much more likely to be due to some deranging effect of the anesthetic or the operation upon the nerve control of micturition which causes retention. The early training of the nurse will have prepared her for overcoming mild cases of retention, but she should seek guidance in all cases of failure to void urine within a few hours after recovery because this is a very important avenue of elimination of the anesthetic and any obstruction of it must be promptly removed.

The nurse will be guided by the surgeon's orders as to the *administration of nourishment*, because this will depend largely upon the surgical condition of the patient as well as upon the individual customs of the surgeon. Patients will be very thirsty from the earliest moment of recovery and will desire large quantities of water. Some surgeons will advise satisfying this longing generously, except, of course, in stomach or other cases where it will be harmful to the wound itself; and other surgeons will prescribe extreme moderation, even to the extent of allowing only small pieces of cracked ice. Every nurse knows that more than the most meager quantity of water aggravates nausea and vomiting in the vast majority of cases, but it is also a fact that plenty of water and the usual prompt vomiting of it will often have a sedative effect upon a turbulent stomach by cleansing it thoroughly of the disturbing contents. This treatment, however, is so heroic that the average nurse shrinks from it and she should not administer it except under definite order because there are many cases in which vigorous vomiting would be very dangerous from the surgical standpoint, to say nothing of the pain suffered by the patient.

In cases where water is forbidden the distressing parched condition of the mouth may be relieved by sponging with a lubricating mouthwash—one containing glycerin, for example. Rectal administration of salt solution may sometimes be employed to relieve the extreme thirst of those patients who must be denied

water by mouth, but this treatment is not given without definite order.

Many patients will be greatly distressed by the lingering disagreeable taste of the anesthetic. The nurse may relieve this with a mouth wash containing a generous amount of lemon juice, tincture of myrrh, etc., according to the preference of the patient.

The point at which food will be given will depend upon the operation and the patient's general condition.

In cases of *rectal anesthesia* there may be one or two special nursing treatments ordered for administration in the beginning of the recovery period. For the immediate elimination of any ether remaining in the colon an irrigation with tepid water may be given. Since hot water would vaporize the ether great care must be taken not to give this irrigation at a temperature higher than body temperature. Following this irrigation there may be an injection of a few ounces of olive oil to be retained for the purpose of allaying any irritation that may have been caused by the ether.

Chloroform.—Recovery from chloroform requires the same watchful nursing as does that from ether, but it is likely to be less eventful. As a rule the patient will remain quiet and pass from his anesthesia into sound sleep.

Nervous and excitable patients may have a period of excitement which will necessitate the same precautions as to *restraint* mentioned for ether subjects, but such cases will be comparatively rare.

Chloroform does not often produce the profuse secretion of mucus nor the swollen tongue so usual in ether subjects, and therefore these patients will not be so prone to the *respiratory obstructions* which frequently complicate recovery from ether. In fact, it is rare that the respirations manifest any noteworthy feature beyond the characteristic softness and quietness.

Nausea and vomiting will also be less frequent, though when vomiting does occur it is more likely to be severe and persistent than after ether. The precautions mentioned for cases of vomiting after ether apply equally to chloroform subjects, with the addition of the one discussed in the following paragraph.

Chloroform subjects very frequently exhibit considerable *pallor* and this will usually be accompanied by marked *depression of*

the pulse. These two symptoms are especially likely to occur just before or during vomiting, and as their severity will usually depend upon the severity of the *vomiting* and the excitement accompanying it, the nurse can often prevent considerable exhaustion and even collapse by judicious management of such cases.

The pulse is likely to be comparatively feeble throughout recovery from chloroform, and, as pointed out in the preceding paragraph, is subject to periods of great depression. This makes it advisable to exercise special care to keep these patients quiet, though, as we have said, quiet recovery is provided by nature in the great majority of chloroform subjects.

Hiccough will occur occasionally, but as in the case of ether it will not often be of great consequence.

Bronchial and pulmonary complications are not frequent after chloroform because the anesthetic is not so irritating to these parts and does not cause the severe congestion of them that ether so often does. However, they are not entirely unknown and the nurse should not forget their possibility.

Though *kidney complications*, beyond albuminuria, are not attributed to chloroform, *the voiding of urine* is an important matter of nursing attention, as in the case of ether.

The discussion of *nourishment* in the case of ether will apply in general to chloroform.

Ethyl Chloride.—Complete recovery of consciousness after ethyl chloride usually takes place within a very few minutes. Occasionally there will be a case of *collapse*, but this will usually occur before the responsibility for the patient has been transferred from the anesthetist to the nurse. However, when collapse does occur it is so sudden and so profound that the nurse should keep its possibility in mind.

Headache, nausea, and *vomiting* occur frequently, and they may be severe.

The *pulse, respirations,* and general condition will, of course, be carefully watched for some time, as in all cases of anesthesia.

Subsequent treatment as to *nourishment*, etc., will correspond in general to that for nitrous oxide and ethylene cases.

For lack of a more opportune moment we must mention now the matter of *the removal of the extra blankets* with which the

anesthetic subject has been safeguarded. There can be no rigid rule laid down as to when this should be done, as there are too many varying factors to be considered. Some of the determining factors, excepting the self-evident one of recovery from the anesthetic, are these: The particular anesthetic given; length of the anesthesia; condition of the patient; season of the year; temperature of the room; and, of course, always the subjective comfort of the patient. For the same reason that the blankets were put on, care must be exercised as to their removal; that is, there must be no chance of exposure taken. In this respect error may be made in both directions, for it is as much a mistake to leave these blankets on so long after recovery that the patient becomes unduly warm as it is to take them off before nature's "heating plant" is in working order. In hospitals there will usually be an established routine, and elsewhere the nurse will need to draw upon her professional good judgment. Entire recovery from the anesthetic is the first requisite. This will mean that nitrous oxide, ethylene, and ethyl chloride patients, if they have blankets at all, will not need them as long as ether and chloroform subjects. A vigorous, generally healthy subject will recover all his functions much sooner after any anesthetic than a weak, devitalized one. After recovery the patient in poor condition may need protection further, while the stronger one may not. In winter longer protection will be needed than in summer. In a warm room more freedom can be taken than in a cold one. In the daytime patients have better resistance, on the whole, than at night. And last but not least, the patient's feelings, which always have an influence upon his condition, will enter into the case to some degree. Naturally, this transition is accomplished gradually—that is, these special blankets are not all withdrawn at one time. This much having been said, common sense will do the rest.

II. LOCAL

Local anesthesia, with its various modifications, is enjoying great popularity at present, and in some clinics it is used almost exclusively. *It has many advantages*, for it eliminates largely the potential dangers and post-operative complications incurred in the administration of an inhalation anesthetic. In the aged and debilitated, in some cardiac patients, or those with a severe

nephritis, in which it would be practically fatal to administer either gas or ether, local anesthesia may be employed with excellent results. The nurse can aid greatly in the promotion and general adoption of this type of anesthesia because she can proclaim its virtues and advantages, and assuage the fear in the minds of most patients who believe that unless an inhalation anesthesia is administered the operation will be painful.

Local anesthesia, or regional anesthesia, is the result of injecting an anesthetic solution, such as novocain or one of its allied chemicals, into the immediate area of the nerves supplying the field of operation. It is divided into two main types: *Field block*, and *nerve block*.

Field block consists in injecting the anesthetic solution about the operative field so that the nerves crossing the field are blocked on their way to the area of operation, while in *nerve block* an effort is made to inject the anesthetic close to the definite nerves which the surgeon wishes to block off. Field block is very useful for goiter and neck operations and the removal of localized superficial benign tumors. Nerve block is very useful in inguinal and femoral hernioplasties, and as a therapeutic agent in the treatment of facial neuralgia.

Field block may be further divided into *paravertebral block* in which the anesthetic solution is injected about the nerves as they leave the bony structure of the spinal column. This type of anesthesia is used quite extensively in kidney operations. If the nerves are blocked as they leave the sacrum it is known as *parasacral anesthesia*. If the nerve trunks are blocked within the spine at the region of the sacro-coccygeal articulation, but the solution not actually injected into the spinal canal, the block is known as *epidural, extradural,* or *caudal block*. Parasacral, combined with caudal block, is quite effective in producing anesthesia for bladder, perineal, and rectal operations.

If the anesthetic solution is injected through a spinal puncture (lumbar puncture) and the nerves blocked within the spine, the result is a spinal block, or *spinal anesthesia*. This particular form of anesthesia is used almost exclusively in many clinics for all abdominal, pelvic, and lower extremity operations.

Ante-operative Preparation.—Usually morphine gr. ⅙, and scopolamine gr. 1/300, are given one hour before the local anes-

thesia is begun, and the dose may be repeated in thirty minutes for nervous patients.

Operative Technic.—For sterilization of needles and syringes pure distilled water should be used and the plunger should always be disconnected from the barrel, and after sterilization the plunger should never be forced into the barrel while it is still hot. The usual armamentarium consists of a 2-c.c. and a 10-c.c. Luer syringe with needles of various sizes, three graduated measuring glasses, and two glass cups. The latter are necessary in case the surgeon should desire to make up his own novocain solution from sterile tablets. If the novocain has been sterilely prepared solutions of one-half, one, and two per cent. should be ready for use. If spinal anesthesia is to be given, lumbar puncture needles which fit the Luer syringes should be added to the anesthetic tray.

Inasmuch as these patients occasionally *faint or go into shock*, it is important that hypodermic solutions of drugs like caffeine, sodium benzoate, strychnine sulphate, adrenalin, and ephedrine be kept near at hand for instant use.

While the surgeon is injecting the anesthetic solution, and during the subsequent operation, a nurse should always stand at the head of the patient reassuring him and making him comfortable by moistening his lips with cracked ice and placing cold wet compresses over the forehead and neck.

In addition, *the nurse should carefully watch the general condition of the patient* and should be well acquainted with the toxic symptoms which may be due to novocain. These are rapid pulse, cardiac palpitation, dyspnea, pallor, cyanosis of the finger tips, nausea and vomiting. In spinal anesthesia these symptoms are quite apt to develop, due mainly, however, to the drop in blood pressure which invariably accompanies the injection of novocain into the spinal canal. This untoward effect of spinal anesthesia is best combated by the Trendelenburg position and the administration of ephedrine and adrenalin. In extreme cases in which the shock is severe an intravenous infusion of 5 per cent. glucose containing either of these drugs may be given slowly.

Post-operative Treatment.—There is very little difference except that in spinal anesthesia cases the head should be kept flat or lowered for at least six hours after operation, or until sensa-

tion returns to the lower extremities. The headache which these patients may complain of is usually controlled by aspirin, or codeine gr. ½. Fluid by mouth may be administered sooner than usual because there are none of the post-anesthetic effects, especially in the field and nerve block type of local anesthesia.

CHAPTER XV

ARRANGEMENT, ORGANIZATION, AND EQUIPMENT OF THE OPERATING THEATER

Operating room nursing is one of the advanced subjects of the profession and should not be undertaken until the student has had a long period of general training in bedside nursing and her courses of instruction in general theory, bacteriology, solutions, materia medica, etc.; for, while she will learn much in the operating room that is new to her, the work there is very largely a matter of piecing together and developing the fragments of knowledge and practice of her preliminary courses.

The task of teaching operating room nursing, and particularly the organization and management of it, to any great degree of detail is a very difficult one because so many variations must be allowed for individual preferences of surgeons, the equipment provided by the given hospital, and the number and qualifications of the members of the staff. There is no one known plan which can be called superior to all others, nor need there be, for if the student masters the fundamental principles of asepsis and antisepsis and has at least the average amount of common sense and a logical, systematic turn of mind she can adapt these principles so as to work out a good system under any given set of conditions. We shall not attempt, therefore, to tell you how to organize and conduct a model operating room, but rather, we shall try so to instruct you in foundation principles that you may equip yourself to organize and manage one that will be a model for your particular limitations or advantages.

As we shall try to present this subject so as to make it useful for all classes of readers, each one will necessarily find much that will not be of value nor interest in her particular case; but the nature of the subject makes this inevitable, so we must beg your indulgence for those parts which may seem too elementary

or self-evident to you, or which seem very foreign to your case, and ask you to believe with us that they will meet the needs of someone else.

Much that must be said here to make the discussion complete will be of more value if studied in combination with the practical experience in the operating room itself; but the practice of plunging a pupil directly into the actual work from which she is expected to gather her knowledge as occasion chances to present itself is to leave her education too much to the mercy of her own enthusiasm and the uncontrollable irregularities of the work. A few preliminary classroom lessons before she is rushed into the confusion and excitement of the operating room will conserve much of the pupil's nervous energy, will save much valuable time for both herself and the other members of the staff, and she will have a sounder education for having acquired it in an orderly, logical way.

We strongly advocate the doctrine that every nurse should be given a thorough course in operating room technic, not only because of the countless number of additional facts she learns thereby which are essential to the highest efficiency in whatever specialty she may adopt after she has graduated, but also because of the general educational value of the discipline it gives her in alertness, accurateness, and promptness of response. However, there are relatively few nurses who should aspire to become operating room "specialists," because the work is a highly specialized type of nursing, and certain natural as well as cultivated qualifications are necessary for more than mediocre efficiency in it. We do not know any more about the universally model operating room nurse than we knew a few moments ago about the universally model operating room itself, but a few pages hence we shall attempt to set up a few standards which will apply universally.

A thoroughly logical sequence in the presentation of the almost innumerable phases of this subject is very difficult to arrange, but as a nurse knows in a general way, before taking up this course, what an operating room is for, she will perhaps do best by beginning here with a picture of its general arrangement and equipment.

THE ROOMS AND THEIR FURNISHINGS

Ideally the operating theater comprises these rooms:

1. Operating room proper
2. Anesthetizing room
3. Dressing room for surgeons
4. Dressing room for nurses
5. Recovery room
6. Work room for nurses
7. Sterile supply room
8. Sterilizing room
9. Storage room

Of course, this exact number of rooms may never be available, but they do represent departments, and whatever space is provided should be subdivided and arranged with these separate features in mind. By the time you have finished this chapter we shall hope to have assisted you to enough ideas to enable you to make the best combination of these departments which your space permits.

When practicable *the operating theater is on one of the higher floors* of the building because in this location it is most likely to be isolated from miscellaneous traffic and undue noise and dust, all of which are menaces and nuisances to an operating room.

1. **The Operating Room Proper.**—*a. Construction.*—This is, of course, *a light room* and it has a northern exposure if possible because of the better diffusion of light it will furnish than one into which strong rays of sunlight stream in some parts, causing deep shadows in others; and a skylight will be an additional advantage. The size of the room is best *no larger than is necessary* for holding the equipment and allowing the minimum space for comfort in moving about. Too large a room is wasteful of time and steps, and too small a one, of course, will be too congested for the easy maintenance of asepsis, because there are always the sterile and the unsterile equipment in more or less close association. Unless one has the pleasure of planning the construction of her own operating room, however, she will not be able to control this feature of the matter beyond exercising good judgment as to arrangement of contents and organization of routine practices.

The walls, floors, and all other structural parts of the room should be *finished in the most hygienic way* possible; that is, they should be of some material that can easily be washed and that will not catch or hold dust readily, for example, tiling, enamel paint, etc. For purposes of higher visibility and greater certainty as to cleanliness they should be white, though a pale green or gray color is often favored because of its restfulness to the eye. Those of you who have had the advantages of training in a hospital built on modern architectural principles will have observed the curve, for instance, in which the wall and the floor meet instead of the right-angle which is such a safe harbor for dust and such a good incubator for germs; you will probably have noticed also that the corners of the walls are fashioned similarly; also, the window ledges were probably slanting or curved, and all window casings, door casings, and other finishings were as free as possible from nooks and corners. This has all been provided for you and you have taken it for granted, but you should appreciate the principles involved so that if it falls to your lot at some time to control the adaptation or construction of some room for operating purposes you may be able to be of the best service.

On this same principle, a good technician does not provide wall hooks in her operating room upon which careless persons may hang various articles which lumber up the room and encourage contamination. The storage and supply rooms are the proper places for all articles which are not needed for the operation, and between operations the storage and supply rooms are the places for everything except the more non-transportable furniture. Under some conditions of room arrangement where space is limited the operating room may have to bear a part of the burden of storage, but in any case one must always follow the principle of keeping all supplies protected as far as possible. This practice is not only refined technic but it is also simple common sense in that it saves the time and labor of unnecessary renovation.

Good ventilation must be provided, and some way should be found to do this without permitting a draught directly through the room.

Heat should be generous, as the temperature of an operating room should be maintained at 75° or 76° F.

b. Furniture.—The ideal material for all operating room furni-

ture is enameled metal, as it is durable and sanitary. White furniture will keep its hygienic condition more clearly before the eye than any color, but a restful gray or pale green in this, as in the walls and floors, has the advantage of being more comfortable to the sight.

The first essential is *the operating table.* There are innumerable models on the market and the one chosen will depend upon local circumstances. Two types are shown with their various attachments in place on pages **325 to 347.**

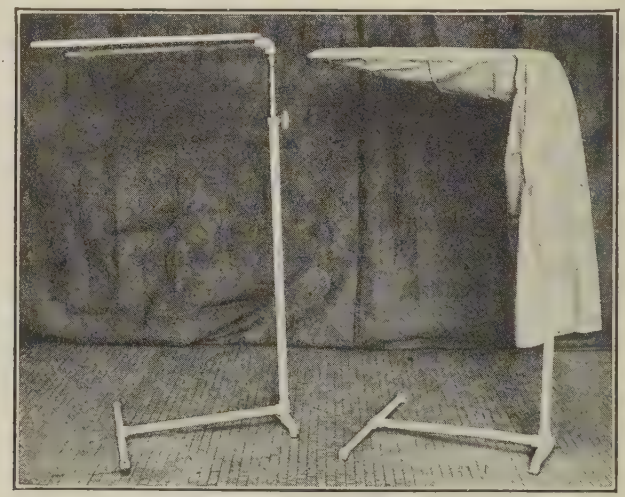


FIG. 43.—ADJUSTABLE INSTRUMENT TABLE WHICH MAY BE EXTENDED ACROSS THE OPERATING TABLE IN ANY LOCATION DESIRED. The cover shown is the one described on page 260, paragraph No. 13.

One or two *instrument tables* are the next essentials. If there is but one operation to be done one table is enough, but where there is to be a session of several cases it will be necessary to have a second table for the reserve supplies. Many varieties are in use and there is no importance in the design of any one except when one is desired which can be placed across the operating table near enough to the wound so that the surgeon can pick up the instruments from it himself. For this purpose a type similar to the one illustrated in Fig. 43 will be needed. This is a very serviceable table as it is adjustable in height, is on rollers, and can thus be easily adapted and moved as convenience requires.

A *table for dressings* and other miscellaneous supplies will be needed in nearly every case. This should be no larger than necessary.

One or more *stretchers* are necessary. In a large hospital where space permits and elevators are used, the wheel stretcher (Fig. 44) will be the one to provide, but in many smaller institutions

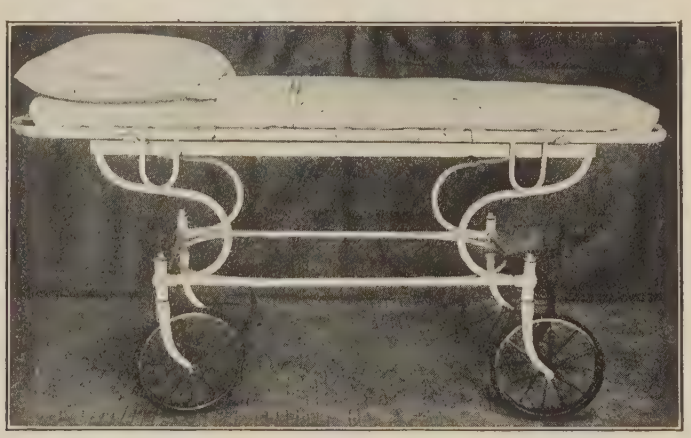


Fig. 44.—Wheel Stretcher.

the carrying variety (Fig. 45) can be made to answer all purposes. Where there is much carrying up and down stairs to be done the special design shown in Fig. 46 is very serviceable.

A *tub or large basin* holding six or eight gallons will be needed in large operating rooms for a 1-1000 solution of bichloride which will serve many useful purposes from time to time.

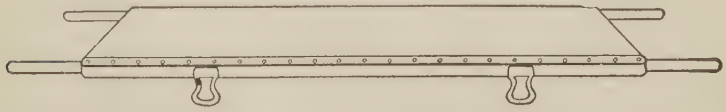


Fig. 45.—Carrying Stretcher. This is, in general outline, the the U. S. Army type.

Other minor articles for this room are, *a seat for the anesthetist or surgeon*; possibly *a small table* for unsterile supplies such as adhesive plaster, bandages, etc.; and a set of *low benches* (Fig. 47) of differing heights for the surgeon to stand upon for some operations. These should range in height from 4 inches to 1 foot, and they should be about 1 foot wide and 2 feet long.

Various kinds can be purchased from hospital supply companies, but they do not furnish the useful gradations in height, and as they are usually made of metal they are not so convenient to handle as are the simple wooden ones suggested in the illustration.

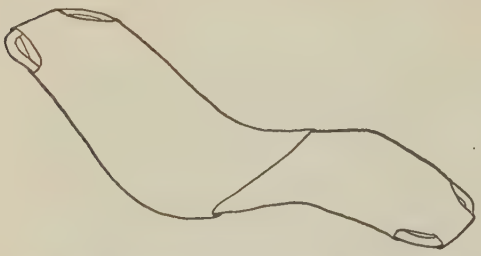


FIG. 46.—STRETCHER SUITABLE FOR CARRYING PATIENTS UP AND DOWN STAIRWAYS. It is merely a bent iron tube covered with canvas slip covers. Some models have a single piece of canvas shaped like the frame and laced to it with a strong cord passed through eyelets in the border of the canvas.

A good *artificial light* is, of course, necessary, but the only general suggestions that can be offered about this are that it should be so placed that the operating table need not be moved when a shift is made from the daylight to the artificial one; and that it should be simple in its fittings for sanitary reasons. Unless one has an elaborately adjustable one it should be supplemented by a simple "drop" or hand light (Fig. 48) which will be needed occasionally in the case of a deep or inaccessible wound. The type shown in the illustration can be draped with a sterile towel when necessary.

This is enough furniture to get along with and the guiding principle in amount of furniture should be not to encumber the room with more than is reasonably necessary.

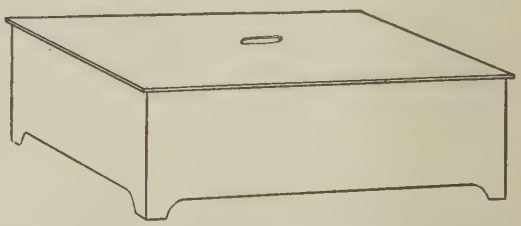


FIG. 47.—BENCH FOR THE SURGEON TO STAND UPON WHEN THE OPERATING TABLE CANNOT BE ADJUSTED SUITABLY IN HEIGHT. These may be very simply made of wood about one foot wide and two feet long, and there should be about six sizes, ranging from 4 inches to a foot in height.

There is one other item to be mentioned in this connection because, while not a necessity, it is a great convenience and a general favorite. It is *the "drum"* (Fig. 49), or metal container in which the dressings and other fabrics are sterilized and from which they are used directly while the operation is in progress. It is made with perforations which are opened

to admit the steam while in the sterilizer, and closed afterward, making the drum very safe and dust-tight. The lids of these drums, when in use, are opened and closed by means of a foot

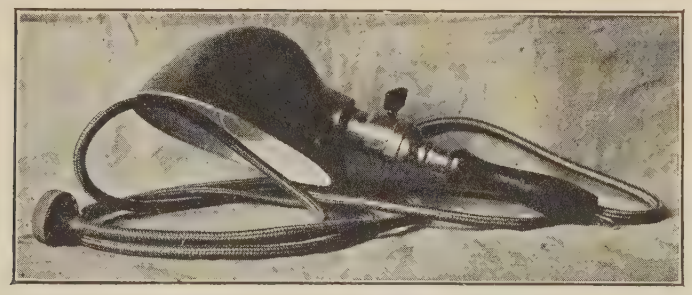


Fig. 48.—Hand Light.

lever on a specially fitted stand, and they thus provide a very convenient storage medium. For a complete system several drums will be needed; for example, the gloves cannot be kept with the wound dressings because they are probably covered with talcum powder and this sifts from them when they are handled; also, you will learn later that it is not good technic to store the sterile gowns with the wound dressings; and it may not be convenient to have the draping sheets and towels in the same part of the room, or even in the same room, with any of the other supplies. Thus, you will need at least four drums if you have any, and when this system is used there is usually included a fifth *drum for hot wet towels and pads* (Fig. 50). This hot towel drum is similar to the others except that it is perforated in the bottom and is fitted over a small water tank which is heated electrically or otherwise, thus allowing the towels to become wet and heated by the steam. Besides the set of drums in use, as outlined, there will be needed reserve ones, so this involves a considerable equipment; and besides, there will sometimes be the consideration of storage space because these stands and

Fig. 49. — Dressing Drum with Pedal Opening Standard.

drums require more space for a given amount of contents than do the simple muslin-covered parcels which you would otherwise use.

c. Sterilizers.—Where space permits it is a great convenience to have the instrument sterilizer (Fig. 51) within the operating room near the instrument table, because frequent reboiling of instruments is usually necessary during an operation and it saves time and handling if the person responsible for the instruments has direct, easy access to this boiler.

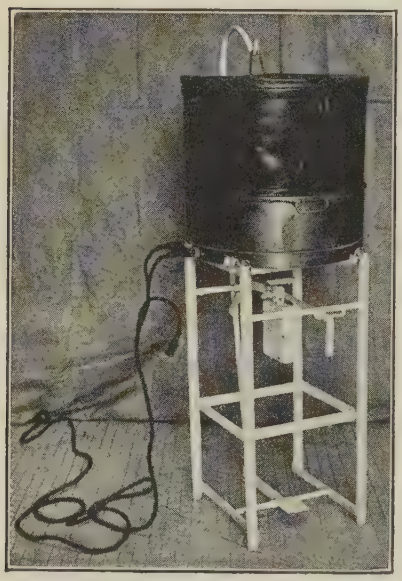


Fig. 50.—Hot Towel Drum with Pedal Opening Standard and Electrically Equipped Steaming Device.

However, when this sterilizer, or any other, is heated by gas or any other *open flame* it cannot be operated either in or near the operating room when ethylene is used as the anesthetic, because ethylene is a highly explosive gas; and even when ether, chloroform, or ethyl chloride is used such sterilizers should be a safe distance from the anesthetist because these anesthetics are highly inflammable. Furthermore, extreme heat, and particularly an open flame, will decompose chloroform vapor and produce phosgene and hydrochloric acid gases which, in a small and poorly ventilated room, may cause serious trouble by their irritant effect upon the eyes and the respiratory tract. When heated by steam, of course, these sterilizers are perfectly safe in this respect anywhere, as are also the electrically heated ones, provided the switch which turns the current on and off is shielded so as not to allow a spark from it to come into contact with any ethylene gas which may be free in the room.

In some cases one sterilizer may have to suffice for all other supplies as well as the instruments; but where possible there should be another large *utensil sterilizer* (Fig. 51) for large basins, etc. This should be in the operating room also when

possible, provided it is safely heated, as indicated above for the instrument sterilizer.

Besides the reason of convenience for having these boilers within the room there is the technical reason that *the steam which they give off renders the air moist* and thereby keeps down dust which might sometimes be a real menace in a dry atmosphere. Some systems of installation very thoroughly conduct this steam directly from the boilers into flues, but the principle remains that

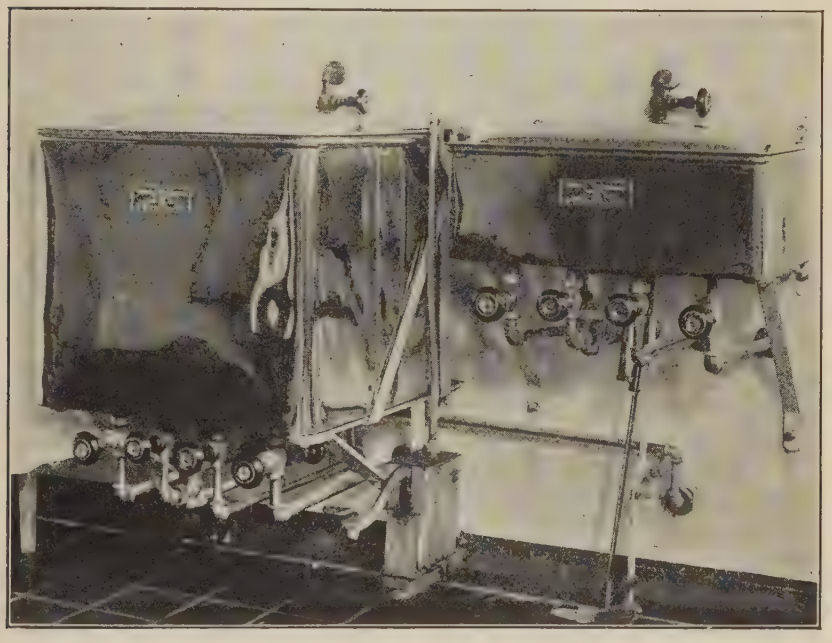


FIG. 51.—UTENSIL AND INSTRUMENT STERILIZERS.

the release of a moderate amount of steam into the operating room is good technic.

Water sterilizers (Fig. 52), one for hot sterile water and one for cold, and equipped with a filter, will also be necessary. These are perhaps best placed outside of the operating room, but their outlets should be extended into the room at some easily accessible point.

d. Miscellaneous Equipment.—There are a great many other devices which are in more or less general use and which, if properly fitted into a corresponding general system, simplify the work. In fact, those who have become accustomed to the more

elaborately outfitted operating rooms and who have never been compelled to work more primitively will consider indispensable many of these items; but as they are more or less luxuries we shall not take space here to enumerate them.

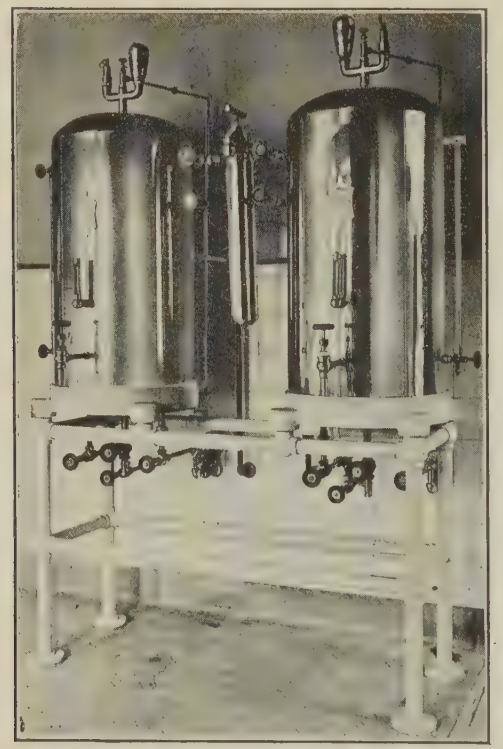


FIG. 52.—HOT AND COLD WATER STERILIZERS. The small cylindrical attachment between them contains a clay filter through which the water is forced before it enters the tanks to be sterilized. This filter is removable and must be cleansed often by scrubbing under running water with a very stiff brush. The cold water tank has a coil of tubes running through its interior through which cold water may be run for cooling the sterile water after it has been boiled. These sterilizers are built to withstand high steam pressure and are usually adjusted so that the water may be sterilized under 15 pounds pressure which, as will be explained later (page 286), raises its temperature about 38° F. higher than that of boiling water.

2. **The Anesthetizing Room.** — *a. Construction.*—The finishing of the walls, floors, etc., should be similar to that described for the operating room, because where there is a separate room for this purpose all of the final preparation of the patient is done in it and it should therefore be sanitarily fitted. It should be a reasonably *spacious room* because a great deal of both sterile and unsterile work will be done in it, and, as pointed out for the operating room, there must be ample room for keeping the sterile equipment well out of the way of the unsterile.

Ventilation and heating should correspond with that of the operating room.

b. Furniture.—First of all, there must be *a table or a wheel stretcher* for the patient. In generously equipped operating rooms where several operations are done in immediate succession there will

doubtless be an extra operating table for this purpose and the patient will be anesthetized upon the table upon which the operation is to be performed. Otherwise, a wheel stretcher or some other type of table will be needed.

There will also be needed a small *table for the anesthetist's supplies.* This may be one that is fitted with wheels so that it may be taken into the operating room during the operation, but the articles needed by the average anesthetist after the anesthesia is established are so few that it is perhaps not advisable to have more than a simple stationary stand in the anesthetizing room.

A *table for miscellaneous articles* will be necessary and this one should be spacious because when the preparation and sterile draping of the patient are done in this room expediency will require that many odds and ends, such as sandbags, pillows, rubber sheets, operating table attachments, etc., be within easy reach.

When there is enough space to make it technically safe the sterile draping supplies may be kept in this room during operations and for this purpose there will be needed *another table,* except when the "drums" are used, in which case one packed exclusively with draping sheets and towels will take the place of this table. The drum is so securely closed that there can never be any objection to having it in the anesthetizing room.

A chair or two may be useful in this room.

When limited space makes a separate anesthetizing room impossible, the anesthetic will be administered in the operating room itself, and this will require great caution as to the sterile drapings and supplies, for there is always more or less commotion attendant upon the induction of the anesthesia and the preparation of the patient in the form of struggling of the patient and the necessary handling of blankets, etc.

3. **Dressing Room for Surgeons.**—*a. Construction.*—The walls and floors of this room should be similar to those of the operating room.

b. Furniture.—*Wash basins with hot and cold running water* are the important essentials of this room (Fig. 53). If possible the water faucets should be of the kind through which the hot and cold water can be mixed by means of levers operable by the foot, knee, or elbow. The number of basins will depend

upon circumstances and the number of surgeons usually operating at one time.

One or more *"arm basins"* should be provided for the antiseptic solution in which the hands and arms are sterilized after scrubbing. Standard ones (Fig. 54), holding enough solution so that the whole arm up to the elbow may be immersed are best, but large ones of other design will serve.

Where possible *individual lockers* should be provided in this room.

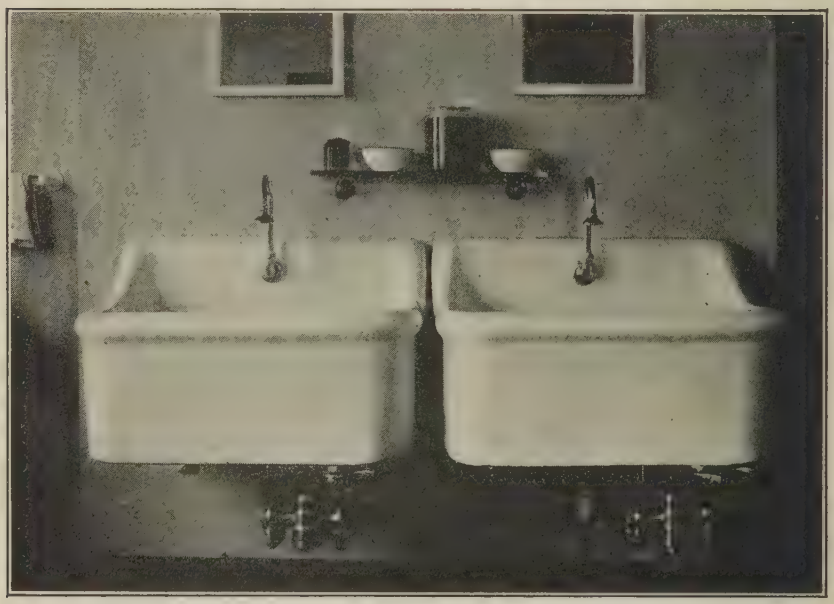


Fig. 53.—Wash Basins with Knee-action Faucets.

Some provision must be made for the surgeons' sterile suits or gowns. *The drum* answers this purpose admirably, but in lieu of this *a table* will be needed for these sterile supplies which will be packed in individual parcels or stored immediately in advance on the sterilely draped table.

A few chairs will be appreciated in the dressing room.

4. **Dressing Room for Nurses.**—This room should be essentially the same in equipment as the one for the surgeons, but it may not need to be as large, though this will depend upon the relative number of nurses using it.

5. **Recovery Room.**—Where space and nurses are plentiful

one room may be equipped with one or more beds and with paraphernalia for the resuscitation of the occasional patient who may need immediate treatment. In other cases this room will be convenient for use in transferring the patient from the operating table to the stretcher, and for the application of bandages, plaster casts, splints, etc.

6. **Work Room for Nurses.**—*a. Construction.*—This is a department of the operating theater which is often neglected in hospital architecture, for the fact is probably overlooked that

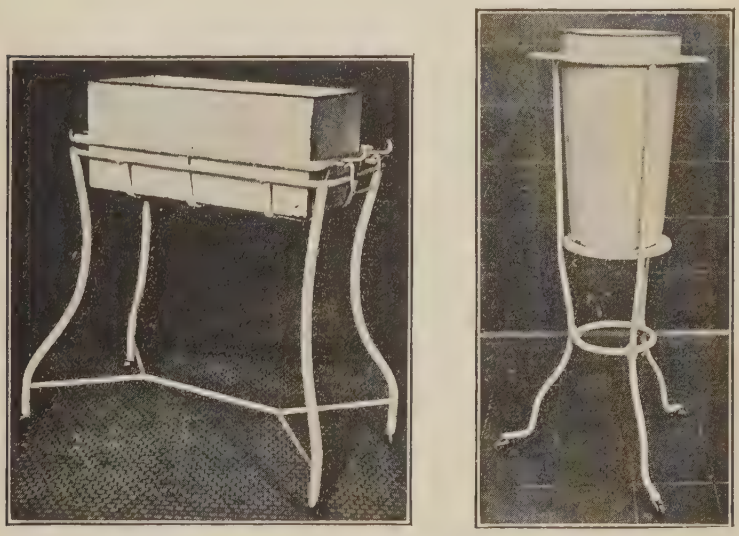


FIG. 54.—TWO TYPES OF ARM BASIN.

it is in this room that the nurse spends the major part of her time and does the bulk of her work. For this reason the work room should, first of all, be *well lighted* both naturally and artificially, and of course *well ventilated* and *comfortably heated.* While it is advisable that this room should be sanitarily finished on the general principles of the operating room, it is not so important.

b. Furniture.—Ample work tables, chairs, dust-proof storage shelves and closets, a gas or other *stove,* and spacious washing *sinks* cover the essential furnishings for this department.

7. **Sterile Supply Room.**—Where practicable this room should be reserved entirely for the sterile supplies, and it should, of course, be kept as *free as possible from dust and moisture.*

We would caution nurses with limited space at their disposal to employ only as a last resort any part of the work room for the storage of sterile supplies, as it will probably be the least clean room of all.

8. **Sterilizing Room.**—*a. Construction.*—The walls and floors of this room must be finished so as to be *waterproof,* as the steam from the sterilizers will ruin anything else, and water will unavoidably be spilled upon the floor from time to time. This room must be *well ventilated,* and because of the water in the sterilizers and plumbing it must be well heated to prevent freezing in winter time.

b. Furniture.—A work table will be needed, and perhaps *storage shelves,* but this will depend upon whether the packing of the supplies for sterilization is done in this room or in the nurses' work room.

The chief equipment is *the steam dressing sterilizer* (see Fig. 69, page 285). The number, size, and variety will be governed by innumerable conditions, but it must be remembered that only those which provide for live steam sterilization under pressure in a vacuum are to be depended upon for absolute sterilization, particularly of large parcels which are difficult of penetration by the steam.

If a room cannot be devoted entirely to this purpose the sterilizing department may have to be combined with either the work room or the supply room, or even both, but strong objections to storing the sterile supplies in the sterilizing room are that the steam keeps the room damp, and there is always danger of water being spilled upon the sterile parcels.

9. **Storage Room.**—This will be a convenient room to have in which to keep infrequently used and reserve unsterile supplies, and miscellaneous portable appliances, but in its absence the nurses' work room may have to serve instead. As advised above, have some corner devoted to this class of supplies and form the habit of leaving nothing portable in the operating room which has no useful immediate function to perform there.

THE PERSONNEL

The scene is now laid and we have a roughly furnished operating theater. Before we go further we shall put some people into it to do the hundreds of things which remain to be done before we are ready for our patient.

1. **Personal Qualifications.**—In the first place, one must be very *strong physically* to endure the strain and severity of operating room work. Hours of application are likely to be longer, and at all times the work is more intense than in any other type of nursing, and a strong body is the only one that will hold out to the bitter end.

Patience and forbearance are also more in demand, and for longer periods than elsewhere. The nature of the work requires that no time be lost and no mistakes made, and consequently everybody is more or less under nervous tension, which means that the nurse will not always receive the consideration from her superior officers which she has been accustomed to receiving in other lines of her work. Orders are more numerous, and often conflicting, and if the nurse has not the maximum amount of the proverbial patience and self-effacement which are always urged upon her profession she will often fare rather uncomfortably in the operating room.

Alertness of mind, self-control, and promptness of conversion of thought into action are other indispensable qualifications for real efficiency. A patient is under an anesthetic and undergoing interference with his life mechanism, which means that emergencies are always arising, and the nurse who "loses her head" is not popular, to say the least, on an operating room staff.

Conscientiousness, though essential and presupposed throughout the professional activities, is obligatory here. When an operating room nurse reflects that a single chance taken under pressure of orders or time may cost the health or even the life of another person she will never yield to any circumstance on this point.

While all the foregoing qualifications are important, perhaps the one which distinguishes the operating room "genius," so to speak, from the others is the *power to think, plan, and work logically, consistently, and methodically.* You will say that this power is an asset in any walk of life, and so it is, but it is useful here to the utmost degree, and its lack is nowhere of more hindrance than in the operating room. This applies not only while the operations are going on but also in the daily routine of the department; for there is a multiplicity of detail in this work which, if muddled by cloudy thought, becomes a mischievous squanderer of time, energy, and service.

These are all desirable qualifications. You have some of them, and perhaps you are particularly fortunate and have all of them; but at any rate you can acquire at least a degree of each of them, and you must do so if you wish to succeed in the operating room and enjoy the work there as you should.

2. **Division of Duties.**—This is a subject upon which it is useless to say much because the number of persons on a staff is determined by varying and numerous circumstances, and therefore the apportionment of the work will be different in all cases. However, the principle of *"division of labor"* should be applied as minutely as possible, particularly in a large operating room where a great number of cases are done in one session. By "division of labor" we mean, of course, the practice whereby each person's work is clearly defined for her so that she is held responsible for the same thing at all times, and so that her activities do not overlap those of the others on the staff. How this is done will depend upon the number of persons on the staff, the arrangement of the operating theater, the number and nature of the operations, etc.; but the principle should be to aim to have as many persons as are necessary to permit division of the work logically up to the point where each one has only the amount of work to do which she can get done with reasonable ease. More work than this for each person causes confusion, delay, and general inefficiency; and less than this amount is extravagance. Variations in the qualifications and capacities of the individuals for hard work, whether they are graduate or pupil nurses, orderlies, etc., will also modify this division of labor, but it will not affect the above guiding principle.

3. **Discipline.**—In general, the organization of an efficient operating room staff as to authority, system, division of duties, thoroughness, attention to detail, promptness, despatch, and team work may be likened to that of the Army. There must be the commanding general with supreme authority, and her staff must be educated to corresponding obedience. Hospital discipline in general is often likened to that of the Army, and the operating room organization should embody this same *discipline in concentrated form.* Emergencies involving life and health are always arising, and there is usually no time for "reasoning why" when orders are received. If each one knows her duties, has

been given the proper instructions as to how to perform them, and has caught the spirit of "each for all," the system will do the rest.

SUPPLIES

(*For Sterilization see Chapter XVI*)

Our next step is to *provide and prepare various supplies* and odds and end which it will be necessary to keep on hand in the operating room. The nurse will have learned about and used many of the things we shall need, but for reference purposes we record here a list of standard items.

1. Adhesive plaster
2. Amputation retractor
3. Aprons
4. Bandages
5. Basins
6. Blankets
7. Brushes, nail
8. Caps
9. Carrel-Dakin equipment
10. Catheters
11. Cautery
12. Cotton
13. Cover for instrument stand
14. Culture tubes
15. Dressings
16. Drugs
17. Gauntlets
18. Gauze
19. Glove covers
20. Gloves
21. Gowns
22. Gutta-percha tissue
23. Hip rest
24. Hot water bottles
25. Hypodermoclysis outfit
26. Infusion outfit
27. Inhalers
28. Instruments
29. Irrigator
30. Irrigator stand
31. Kelly pad
32. Masks, anesthetic
33. Masks, face
34. Mouth gags
35. Nail cleaners
36. Needles, suture
37. Needles, syringe
38. Packing
39. Pads, abdominal
40. Pads, table
41. Pillows
42. Rectal tube, with funnel
43. Rubber bands
44. Rubber dam
45. Rubber sheets
46. Rubber tubing
47. Safety pins
48. Salt solution
49. Sandbags
50. Sheets
51. Splints
52. Stockings
53. Stomach tube, with funnel
54. Suction apparatus
55. Suits for surgeons
56. Suture material
57. Syringes
58. Thermometers
59. Tongue forceps
60. Tourniquets
61. Towels

We shall now take up the supplies just enumerated in the order, and under the number, which they hold in the list and discuss them from the operating room standpoint.

1. **Adhesive Plaster.**—This needs no comment except that there must be plenty of it in assorted widths.

2. **Amputation Retractor.**—Some such article as this will be necessary in the absence of the special metal instrument (C of Fig. 113, page 376) for the purpose, and it will be used to hold back the soft parts while the bone is being sawed off in a major amputation operation. It is made of strong muslin and there should be two patterns—one with two tails for use on the femur or humerus, and the other with three tails for the two bones of the forearm or the lower leg. For the two-tailed one (A of Fig. 55) cut the muslin 24 x 24 inches, fold double, cut halfway up through the middle the long way, and stitch in all edges. For the three-tailed one (B of Fig. 55) cut the muslin 30 x 24 inches, fold double the short way, cut in thirds halfway up the long way, and stitch in all edges.

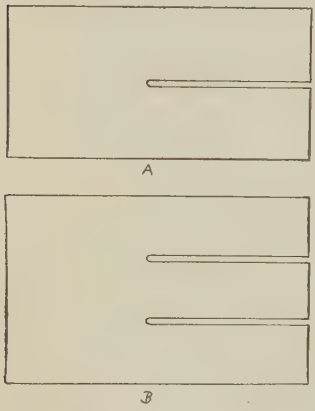


FIG. 55.—AMPUTATION RETRACTORS. *A*, the two-tailed one for use in the amputation of one bone; *B*, the three-tailed one for use in the case of two bones.

3. **Aprons.**—(*a*) *Muslin.*—These will be made after the pattern of the ordinary "butcher's" apron. They may be used over the gown or suit where these two garments are not changed between operations.

(*b*) *Rubber.*—These may be purchased ready-made, or they are very easily made from a piece of rubber sheeting by the same pattern as that used for the muslin one. They will probably not be used as a routine, but there should be several on hand as occasions will arise when the surgeon or the nurse will need their protection.

4. **Bandages.**—Several of the elastic (Esmarch) bandages should be on hand for use on extremities in a case of "bloodless" operation. Plenty of all sizes of the gauze, muslin, flannel, plaster of Paris, and starch ones should be in stock. For details about all bandages see pages 414-420.

5. **Basins.**—A good assortment of white enameled metal

basins should be on hand for both sterile and unsterile use. The kidney-shaped one is always useful, and for a great variety of purposes; large round ones holding a gallon will be needed for rinsing hands in salt solution, etc., during operations; smaller ones holding a pint, perhaps, will be serviceable for wound or dressing solutions; long, narrow, shallow ones will serve for sterilizing in solutions such things as instruments, catheters, etc. The supply of all kinds should be generous.

There must also be a few *floor basins*. Any kind will do, but a great deal of noise will be saved if the light-weight "composition" ones are used, especially if the floor is of tile or cement.

6. **Blankets.**—Plenty of blankets will be needed, and there should be warm ones in readiness in a blanket warmer, the sterilizer, or upon a radiator for emergency use in shock cases.

7. **Brushes, Nail.**—As these will have to be boiled repeatedly a very plain kind should be used, that is, the backs should be unvarnished, and the coarse bristles will last better than fine ones.

8. **Caps.**—(*a*) *Surgeon's.*—These are best made of muslin and may be merely a skull cap (A of Fig. 56) or they may be a combination of cap and face mask (C of Fig. 56), in which case it is better to use a thinner material as the heavier one may be too warm and cumbersome. The surgeon will probably wish to make his own selection of design. (*b*) *Nurse's.*—These are best made of muslin also, and any design that will cover the hair well will be a good one (B of Fig. 56) and the combination of face mask and cap described for the surgeon (C of Fig. 56) may also be used by the nurse.

9. **Carrel-Dakin Equipment.**—See Chapter XX for details about the Carrel-Dakin treatment. The only special items, however, which need be kept on hand in the operating room are the wound tubes and a small quantity of Dakin's solution.

10. **Catheters.**—The kinds used on the wards (glass, rubber, Lisle thread, etc.) are likely to be called for occasionally, the rubber ones being sometimes used as drainage tubes.

11. **Cautery.**—There are several kinds of cautery which are described in Chapter XVI, pages 289-291, under "Sterilization," as the cautery is, of course, a sterilizing agent.

12. **Cotton.**—Plenty of both the absorbent and the non-absorbent cotton should be on hand.

13. **Cover for Instrument Stand.**—This will be a slip cover, simply a long narrow bag (Fig. 43, page 244) which is designed to envelop the instrument stand which extends across the table for operations. This bag should be made long enough to reach well downward toward the base when the stand is extended to

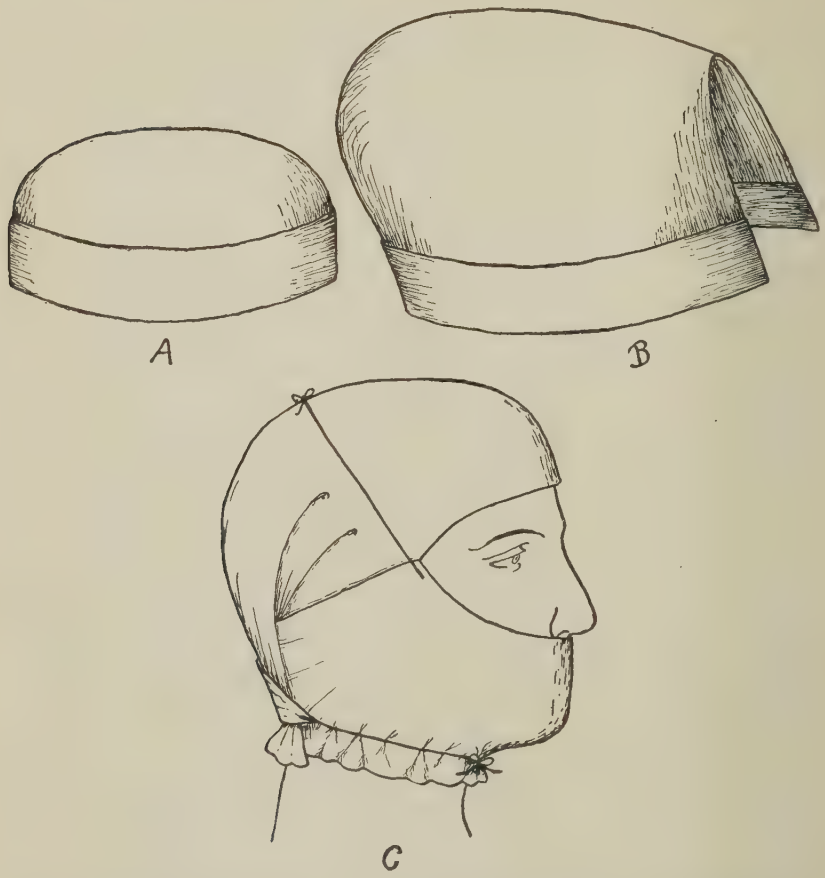


Fig. 56.—Operating Caps. *A*, simple skull cap for the surgeon; *B*, nurse's cap; *C*, combination cap and mask suitable for either surgeon or nurse (see directions for making cap *C* on page 270).

its highest capacity, as it will then enable the instrument passer to adjust the height of the table sterilely at all times and will furnish the simplest means of covering the unsterile standard. It should be made of strong muslin, and the size of it will need to be adjusted to the particular table chosen.

14. **Culture Tubes.**—Cultures will frequently be taken from wounds and a few tubes should always be ready (Fig. 57). The one containing the culture medium must be provided by a laboratory, but the other one may be made in the operating room as follows: Make a cotton swab on a long wooden or wire applicator; put this into a small glass test tube, allowing the end to project about half an inch; plug the tube loosely with cotton, and then put it into a larger test tube and plug this with cotton, and sterilize. The outer tube keeps the inner one sterile so that it may be handled by a sterile person, and the inner one is for the reception of the swab after the culture has been taken.

Fig. 57.—Culture Tubes. *A*, tube containing a culture medium; *B*, tubes containing swab for taking specimen of pus from the wound.

15. **Dressings.**—These will be somewhat as follows:

Sponges.—For the small square sponge or *"wipe"* cut a square yard of gauze into quarters both ways, making pieces 9 inches square. Using either one or two layers of this, fold into a square of about 3 inches. There are many ways of doing this, and each hospital will have its own traditional method, but the only important point about it is to have the cut edges folded inside.

Another kind of sponge, sometimes called the *"handkerchief wipe,"* is made of bandage gauze. This is cut about 12 inches square and is hemmed like a handkerchief. This wipe is washable, and because of its greater area it is less likely to be overlooked in a wound.

For use on sponge forceps in small and deep wounds there will also be needed a compact little bunch of gauze. For this cut the gauze about 6 inches square, fold diagonally, lay it across the ends of the fingers (on the palmar side) with the apex of the triangle outward, and with the other hand gather the points of the triangle together, twist them securely, and then invert over them the cap that was thus made on the fingers. This sponge is sometimes called a *"cherry."*

Wound Dressings.—Cut the gauze ½ yd. x 1 yd. and fold like the needle book as described on page 305, thus making a flat *"folded dressing"* of about 4½ x 9 inches in size.

For wounds from which there will be drainage a loosely arranged dressing will be necessary. Spread out a square yard of gauze, and then turn all corners to the center loosely and repeatedly (about 5 times) until the whole can be handled as a loose ball. *"Fluff"* will sometimes be the local name for this dressing.

For the extremities a dressing in the shape of a roller bandage will often be desirable. Fold a square yard of gauze lengthwise into a strip about 4½ inches wide and then roll it like a bandage. Perhaps the neatest way of folding it is to turn the selvaged edges to the middle first and then double the piece twice. A common name for this dressing is *"rolled compress."*

16. **Drugs.**—Local preferences will determine the stock of drugs to a large degree, but the following list will be a general guide:

Adrenalin
Albolene, liquid
Alcohol
Argyrol
Aristol powder
Aromatic spirit of ammonia
Atropine (hypodermic)
Benzine
Bichloride of mercury
Boric acid (powder and crystal)
Burow's solution (aluminum acetate)
Caffeine (hypodermic)
Camphor (hypodermic)
Carbolic acid
Carbon dioxide
Castor oil
Chloretone
Chloroform
Cocaine
Codeine (hypodermic)
Collodion
Dakin's solution
Ephedrine
Ether
Ethyl chloride
Ethylene
Formalin
Glucose solution, 5%
Glycerin
Green soap
Harrington's fluid
Hyoscine (hypodermic)
Iodine, tincture
Labarraque's solution
Lime, chlorinated
Lubricant (vaseline, K-Y, etc.)
Lysol
Magnesium sulphate
Mercurochrome
Morphine (hypodermic)
Nitrous oxide
Novocain
Olive oil
Oxalic acid
Oxygen
Paraldehyde

Peroxide of hydrogen	Sodium carbonate (washing soda)
Picric acid	Sodium chloride
Potassium permanganate	Strychnine (hypodermic)
Scopolamine	Talcum powder
Silver nitrate, solution and "stick"	Vaseline
Sodium benzoate (hypodermic)	Water, distilled

17. **Gauntlets.**—These will simply be loose muslin sleeves which will reach from well above the elbow to the hand. They will be used with the short-sleeved suits and gowns in combination with the muslin apron (Paragraph No. 3) and will be kept in place with a rubber band, a spring clip, a safety pin, etc.

18. **Gauze.**—See "dressings" (Paragraph No. 15).

19. **Glove Covers.**—Though not necessary, these covers will be a great convenience and they are very simple to make. Cut a piece of muslin about 12 x 31 inches, hem the ends, fold each end to the middle of the piece, and stitch the sides so as to make a double envelope (Fig. 58) into which the gloves may be slipped separately; then fold through the middle into a compact parcel.

20. **Gloves.**—(*a*) *Rubber.*—There are many kinds of rubber gloves on the market and each surgeon, as a rule, has his favorite among them. They are made in many sizes and every person should be well fitted because too tight a glove is very uncomfortable and one that is too large is a hindrance. Many gloves should be kept in reserve as they do not last long and they should not be used except when in good condition. (*b*) *Cotton.*—These are not often used but occasionally they are slipped over the rubber ones when it is difficult to handle such parts as the intestines, the breast, etc., as the rubber gloves are likely to slip awkwardly on these parts. Any good cotton glove will answer the purpose, but relatively large ones must be provided as they shrink considerably in sterilization.

21. **Gowns.**—These should be made of heavy "twilled" muslin and several sizes should be provided. They must be made to close in the back, and tape strings that may be tied are better than buttons for closing them as they withstand the wear and tear of the laundry better. These gowns will have either long or short sleeves, the long ones being used when the gown is changed between operations and the short ones when the

gauntlets (Paragraph No. 17) and aprons (Paragraph No. 3) are used. The chief point to notice about the gown is that the long sleeves are long enough to be securely tucked under the

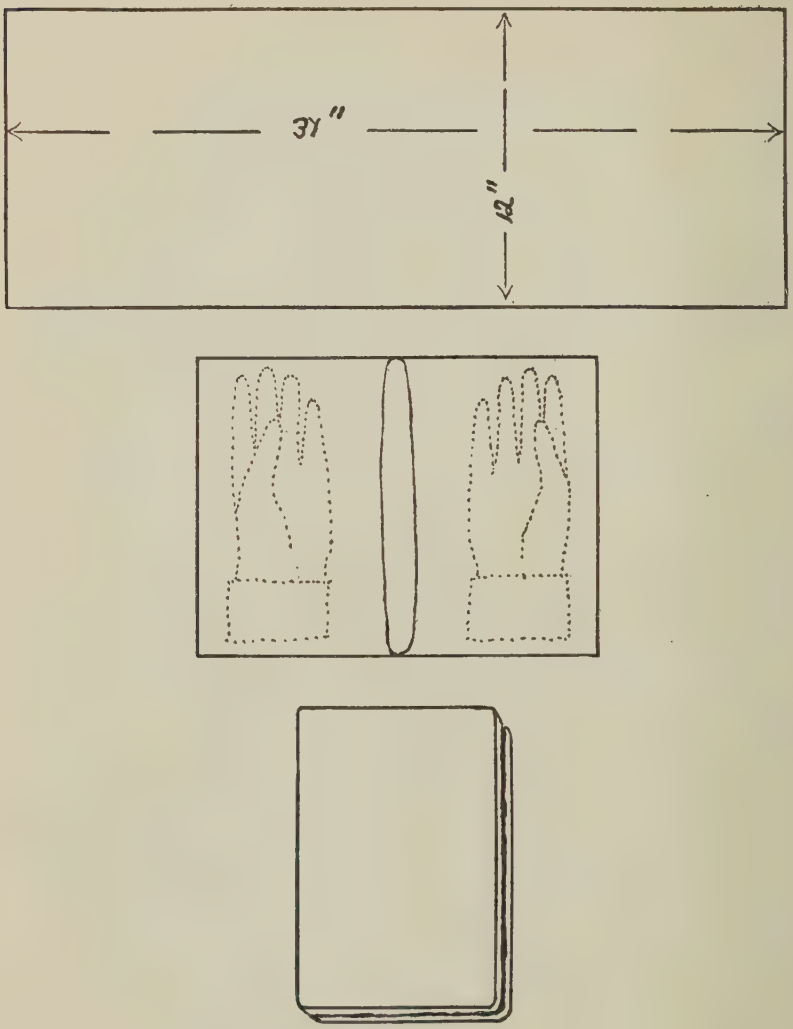


Fig. 58.—Glove Cover.

rubber gloves, and that the short ones reach well to the elbow so that they may be kept securely within the gauntlet.

22. **Gutta-percha Tissue.**—This will be purchased in thin sheets of about one square yard each. It is useful for many

purposes both sterile and unsterile, such as covering dressings, for drains, etc. Its preparation for sterile use is discussed on page 300, and under "Drains" on page 357.

23. **Hip Rest.**—This will be needed occasionally for the application of the hip-spica bandage. The U-shaped metal one (Fig. 59) is especially useful in the case of plaster cast application in those cases where there is not a special table for the purpose.

24. **Hot Water Bottles.**—These will sometimes be needed for patients who are in poor condition.

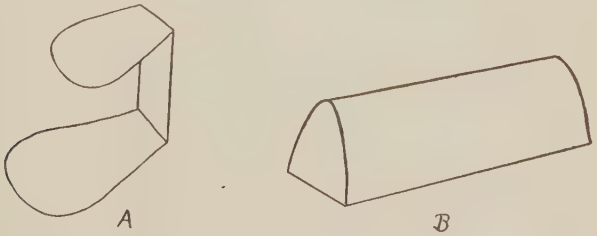


Fig. 59.—Two Types of Hip or Pelvic Rest. *A*, metal design which is especially suitable in the application of a plaster of Paris hip spica; *B*, a simple wooden block which will be better suited than *A* for use in applying a hip spica bandage to a conscious patient, as it will be long enough to reach across the patient's body and thus to balance him comfortably, whereas the metal one is narrow, is too uncomfortable for a conscious patient, and usually requires an assistant to keep the patient balanced upon it.

25. **Hypodermoclysis Outfit.**—A very convenient arrangement is the one suggested in A of Fig. 60. Two pieces of rubber tubing about two feet long are connected to a glass Y-tube by means of which they may be attached to the irrigator tubing (Fig. 62). Two needles of medium caliber and about 3½ inches long (1 and 2 of Fig. 60) will be necessary and these may be connected to their tubing by means of metal or glass adapters (3 and 4 of Fig. 60). If the adapters are not used a small enough rubber tubing to fit tightly over the needles will be necessary.

Another method, which does away with the irrigator, is *to use the solution directly from the flask* by means of siphonage (Fig. 61). A rubber stopper which fits the flask tightly has one long glass tube through it which reaches nearly to the bottom

of the flask, and another short one which barely reaches through the stopper. The delivery tubing, about six feet long, is attached to the long glass tube and a rubber bulb is used on the short one for pumping air into the flask to start the siphonage. To operate this set merely be sure that the needle is being held considerably below the level of the flask, pump air into the flask until the

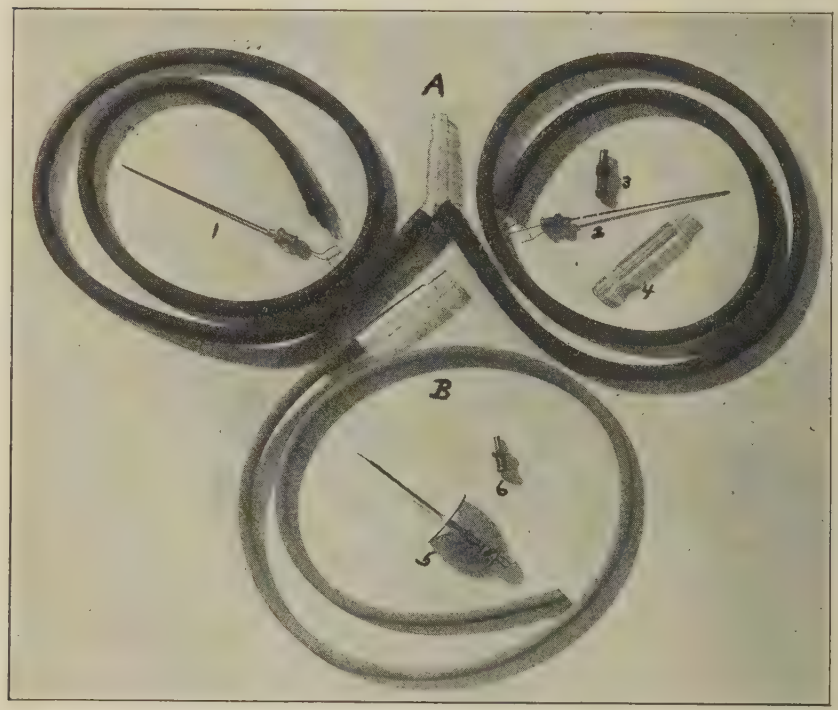


FIG. 60.—HYPODERMOCLYSIS AND INFUSION SETS. *A*, hypodermoclysis set; *1* and *2*, needles about 3½ inches long and of fine caliber; *3*, metal adapter for connecting rubber tube and needle; *4*, glass adapter for same purpose; *B*, infusion set; *5*, infusion needle. This is a special needle (Unger's) which is fitted with a horned flange upon which it rests very stably without being held. An ordinary needle of somewhat larger caliber than the hypodermoclysis ones is also used for infusions; *6*, metal adapter necessary for use between this special infusion needle and either of the other adapters (*3* and *4*), which have larger tips.

solution begins to flow, and then remove the bulb. It is necessary, of course, to have a bulb with a valve to prevent a backflow of the air. An ordinary atomizer bulb is that kind, and if the flask stopper and the other connections do not leak a medium-sized atomizer bulb is very suitable for this purpose.

26. **Infusion Outfit.**—For this the arrangement in B of

Fig. 61.—Device for Administration of Hypodermoclysis or Infusion Directly from Flask in which Saline Solution Was Sterilized. See paragraph 25 for description of this device.

Fig. 60 may be used, the rubber tube being about 2 feet long and fitted with a glass connecting tube so that it may be attached to the irrigator (Fig. 62) in the same way as that suggested for the hypodermoclysis set. The infusion needle may be of larger caliber than the hypodermoclysis ones because the solution can be injected into the vein at a faster rate than that at which the tissues will absorb it in the case of the hypodermoclysis. The needle shown in the illustration (5 of Fig. 60) is the special Unger needle, but ordinary ones may be used also. The flask outfit described above under "Hypodermoclysis Outfit" is applicable, of course, to the infusion as well.

27. **Inhalers.**—There are many kinds for each of the several anesthetics, and local conditions will determine the choice among them. In general, however, in a well-equipped general hospital there will probably be a number of the simple open face masks for the administration of ether, chloroform, and ethyl chloride; the re-breathing type of nitrous oxide-ether inhaler; a vaporizing outfit for ether or chloroform; an apparatus for the administration of nitrous oxide or ethylene; and there may also be an intratracheal insufflation apparatus.

28. **Instruments.**—This equipment, both as to kind and amount, will be determined by the kind of surgery likely to be done, and each surgeon will have his own preferences among the many varieties of instruments made for any given purpose. General probabilities, however, are pointed out in the chapter on instrument passing (Chapter XVIII).

29. **Irrigator.**—There are many kinds (Fig. 62) and no one is necessarily better suited to operating room purposes than any other. The glass one is very satisfactory because the contents are visible, but it is more troublesome to care for than the enameled metal one.

30. **Irrigator Stand.**—This will be needed for wound irrigations, infusions, etc., and the design is not important (Fig. 62).

31. **Kelly Pad.**—The nurse will have become familiar with this type of pad, either under this name or some other, on the wards, and its use in the operating room is pointed out under "Operative Positions and Draping" on page 336. An improvised one is illustrated in Fig. 173, page 469.

32. **Masks, Anesthetic.**—The special variety will usually be left to the anesthetist. See under Inhalers, Paragraph No. 27.

FIG. 62.—IRRIGATORS AND STANDS.

33. **Masks, Face.**—There are many designs for simple masks which merely cover the mouth and nose and the illustrations in Fig. 63 show representative designs for this article. Designs A and B consist merely of several layers of gauze or of one heavy piece with tapes sewed to the corners for tying around the head

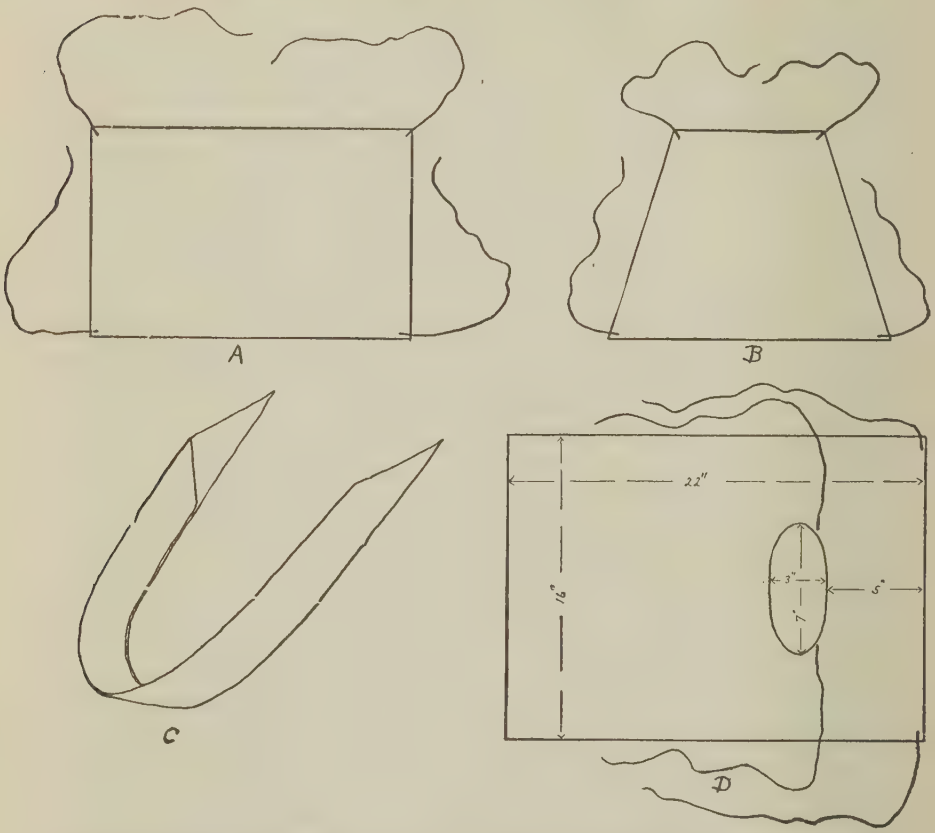


Fig. 63.—Face Masks. *A*, several layers of gauze stitched together, and having tape strings attached to each corner for tying around the head, and neck; *B*, made similarly to *A*; *C*, piece of gauze folded as described in Paragraph No. 33; *D*, made either of one layer of heavy gauze or of several layers of thinner gauze, with tapes attached for tying in place as illustrated in *C* of Fig. 56, page 260.

and neck. Design C is merely a piece of gauze cut 30 inches square, folded diagonally by turning two diagonally opposite corners to the center of the piece and continuing to fold in this direction till the strip is 5 or 6 inches in width. It is adjusted by placing the middle of it over the face, twisting the ends till

it fits neatly, and then tying over the crown of the head. Mask D of the illustration is the outline of the one which is shown adjusted to the wearer in C of Fig. 56, page 260.

34. **Mouth Gags.**—There are many designs from which to select, and two representative types are illustrated in Fig. 42, page 231.

35. **Nail Cleaners.**—Any kind that can be boiled will do, but there is probably nothing better than the simple orange stick.

36. **Needles, Suture.**—These are properly classified as instruments and the advice given about instruments in paragraph 28 above will apply to suture needles.

37. **Needles, Syringe.**—A plentiful supply of all sizes for each type of syringe should be on hand.

38. **Packing.**—Plenty of gauze packing of assorted widths from ⅛ inch, or even less, up to 2 inches should be in readiness at all times. The length of this packing should, of course, vary with the width, the ⅛-inch size being perhaps a foot long, the intermediate widths correspondingly longer, and the 2-inch one being not less than 5 yards because when packing of this width is used in the operating room a large quantity will be needed and in most cases it will be very important that it be in one uncut piece. To make this packing, select a bandage four times as wide as you wish the packing to be and fold in these steps: Fold down about ¼ inch at the ends; turn in each edge lengthwise to the middle of the strip; and then fold lengthwise through the middle again, leaving the raw edges inside, of course. For convenience in handling, each piece may then be rolled into a compact disc and bound with a string, or it may be folded fan fashion into a compact parcel and tied through the middle with a string.

39. **Pads, Abdominal.**—These pads are used for blocking off the operative field in abdominal operations, and several sizes and shapes will be needed (Fig. 64). Pads A, B, and C of the illustration are made of from 6 to 10 layers of gauze carefully turned in and sewed at the edges, and with a piece of strong tape firmly sewed to one corner so that they may be secured in some way on the outside of the wound to prevent their being lost in the abdominal cavity. In some cases it may be the custom to sew a heavy iron ring to the end of the tape. This ring is conveniently pinned to the draping sheet or, because of its

weight and the report it gives if the pad accidentally falls to the floor, it is a very satisfactory means of keeping track of the otherwise somewhat elusive pad. In other cases the tape will be fastened to the sheet with a safety pin or clamp, or it will

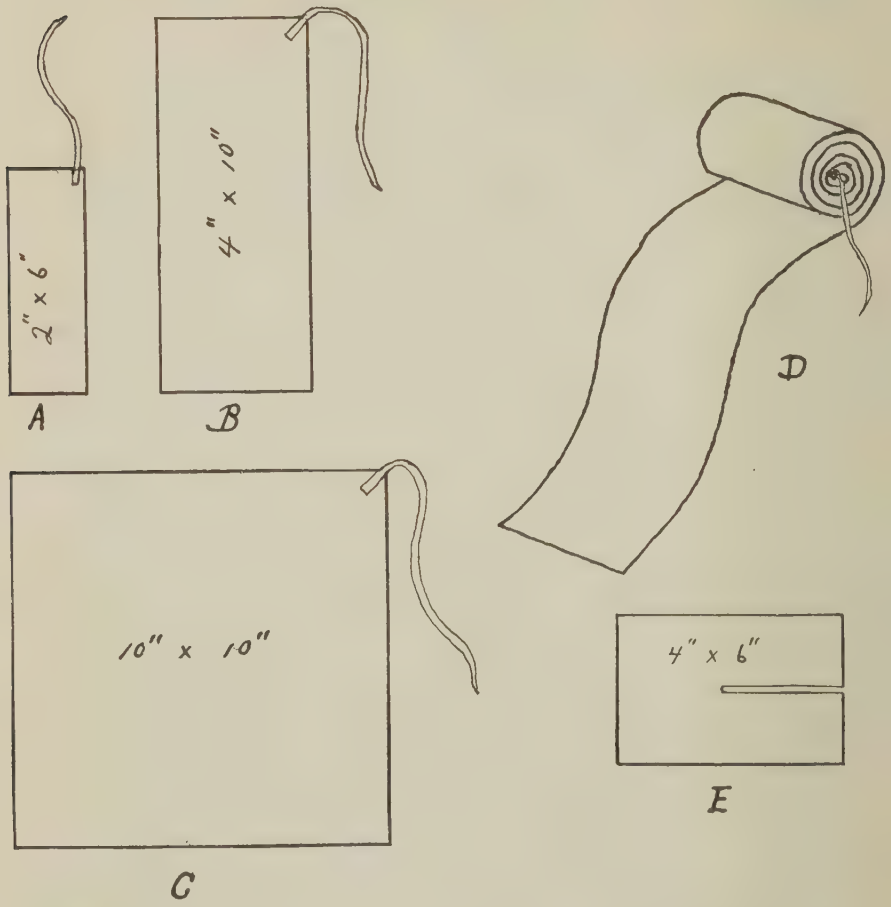


FIG. 64.—ABDOMINAL PADS. *A, B,* and *C,* are made of gauze in dimensions of 2 x 6 inches, 4 x 10 inches, and 10 x 10 inches respectively, and should be from 6 to 10 layers thick; *D,* is 1 yard long, 5 inches wide, and 10 layers thick; *E,* is 6 inches long, 4 inches wide, and 6 layers thick, and is split into two tails at one end for use in folding about the appendix during its removal.

simply be marked by the attachment of an artery clamp to it. Pad D is about 1 yard long, 5 inches wide, and 8 or 10 layers thick. It, also, will have a tape attached, and it should be rolled into the shape of a roller bandage, with the tape inside, because

it will be more convenient to handle in this form. Pad E of the illustration is especially designed for use in the removal of the appendix. It will be made about 6 inches long, 4 inches wide, and 6 layers thick; it will be split half the way up from the middle of one end and will be finished about the edges like the others. This pad will not need a tape because it will be used only on the surface of the wound.

40. **Pads for the Operating Table.**—The table must always be covered with a soft pad. Often this will be supplied with the table by the manufacturer, or soft cushion rubber and other kinds may be purchased, but one is easily made by covering a folded blanket or any similar material with rubber sheeting. The rubber sheeting should never be omitted but it should be covered with a muslin sheet before a patient is placed upon it.

41. **Pillows.**—For all operating room purposes the hair pillow is better than any other. There will, of course, be the ordinary ones for the patient's head, and uses will be pointed out later for several smaller sizes—to fit under the back, the knees, and the patient's head in some unusual positions.

42. **Rectal Tube.**—This will sometimes be needed for stimulating enemata, etc., and it should be kept in readiness with a funnel attached.

43. **Rubber Bands.**—There should be a good assortment of rubber bands as various sizes will be used occasionally for drains. Also, when the muslin gauntlets are used a light-weight band about the arm will be very convenient for keeping them in place.

44. **Rubber Dam.**—This is a soft gum rubber which is made in sheets of various sizes, and it is used chiefly for drains, usually the "cigarette" drain. As this will be made up after it is sterilized it will be taken up again under "Instrument Passing" in Chapter XVIII, and the sterilization of it is taken up on page 304.

45. **Rubber Sheets.**—A generous supply of these sheets should be provided, and they should be used unstintingly to protect both patients and operating table in cases where there is likely to be fluid of any kind spilled about. A heavy gum rubber sheeting is the softest kind, is more agreeable to use, and is easier to cleanse than any other, but it is relatively expensive. However, it is about the only kind that should be used because

those which are made partially of cloth cannot easily be kept clean enough for operating room purposes. Pieces one yard square will be the most serviceable.

46. **Rubber Tubing.**—The operating room should possess a good supply of all sizes of rubber tubing as it is used for many different purposes. As to the storage of this it is a good thing to keep in mind that it seems to keep soft and fresh longer if it is hung from one end under slight tension.

47. **Safety Pins.**—Many of these, of course, are always needed.

48. **Salt Solution.**—(*a*) *Concentrated.*—For purposes of irrigation or of rinsing gloves during the operation the normal salt solution (0.9%) made from ordinary salt and the filtered water from the water sterilizer will answer. A convenient way to provide this is to sterilize the salt in concentrated solution, 10% for instance, in flasks holding enough for one day's use. The proper amount of this solution is easily added to water when needed, 2½ ounces of the 10% solution in a quart of water making the normal solution nearly enough for purposes of irrigation or rinsing.

(*b*) *For Infusions.*—For intravenous injection a more refined solution must be made because this is introduced directly into the blood stream where any but the normal solution can cause serious damage. The drug market supplies salt specially prepared for the infusion solution, and this will usually include small proportions of potassium chloride and calcium chloride with the sodium chloride, but sodium chloride alone is extensively used. Advice to nurses as to how to make this solution varies somewhat in the matter of strength, nine tenths of one per cent (.9%) being the most concentrated permissible. The U. S. P. formula is 8.5 grams to 1000 c.c. Since filtration and sterilization undoubtedly entail some evaporation of the water, and thereby a slight concentration of the original solution, the operating room nurse who makes her own solution should mix the .85% solution. This will amount to 130 grains to a quart. Chemically pure sodium chloride and distilled water should be used.

After the salt has been thoroughly dissolved in the water the solution must be filtered through fine filter paper a sufficient number of times to make it perfectly clear. Then it should be

put into quart-size glass flasks for sterilization, the flasks being very securely stopped with plugs of non-absorbent cotton covered with gauze and tied well down over the mouth of the flask with strong tape. Covering the neck of the flask in this way insures its remaining sterile which will be important in pouring the solution from the flask for use. The cleanest and easiest practice in making this solution is to filter it directly from one flask to another each time.

49. **Sandbags.**—For the adjustment of the patient's position upon the table it will often be necessary to have sandbags of various sizes. The sand for these bags should be fine and clean, sea sand being the best; the bags should be made of heavy

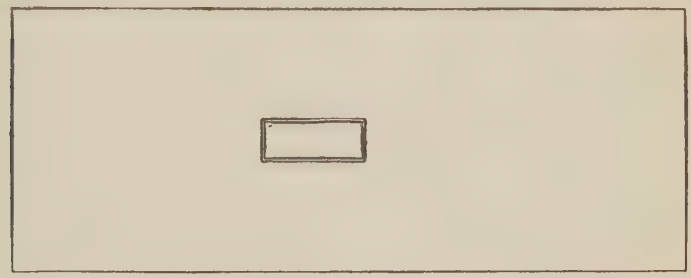


FIG. 65.—LAPAROTOMY SHEET. This is simply a large muslin sheet with an oblong opening cut in the center. The size of this opening should not be less than 4 x 8 inches, and much larger openings are often preferred. See use of this sheet in Fig. 78, page 328.

canvas or "ticking"; and this should be covered with strong rubber sheeting. Care should be taken not to fill them too full, as a slightly flexible bag is more adaptable than a solid one.

50. **Sheets.**—(*a*) *Plain Muslin.*—A generous supply of large heavy muslin sheets must be on hand for both sterile and unsterile purposes. (*b*) *Laparotomy.*—Another type of sheet which is very easily made and which is a very convenient article is the "laparotomy" sheet (Fig. 65). This is merely a muslin sheet which is long enough to cover the entire table and which has an opening about 4 x 8 inches, or larger, cut in the center of it—this must, of course, be durably bound with tape. This sheet will be useful for a great many operations, and we point out its uses under "Operative Positions and Draping" in Chapter XVII.

51. **Splints.**—A variety for all purposes should be kept ready for use.

52. **Stockings.**—For operations in the lithotomy position (Fig. 91, page 338) it is desirable to have large muslin stockings (lithotomy stockings) which will slip over the patient's feet and the table fixtures loosely, and extend well over the patient's abdomen and down over the side of the table. Any nurse can

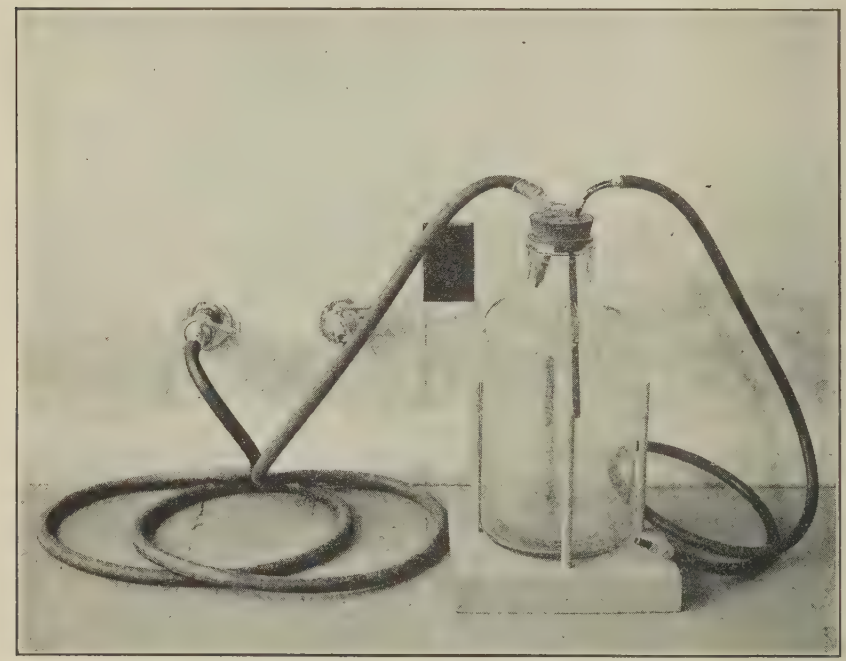


Fig. 66.—Suction Bottle. This particular outfit is operated by the operating room high-pressure steam system. The connecting tube in the free end of the tubing is of metal since the technically proper place for this equipment is on the floor where a glass connector would be very short-lived. This part of the suction outfit does not need to be sterile, as a sterilized tube about six feet long will connect it to the suction tip.

design a stocking suitable for this purpose as the chief requisite is that it should be of generous size.

53. **Stomach Tube.**—This will be needed for an occasional lavage, and it should be kept ready with a funnel attached.

54. **Suction Apparatus.**—This is one of the few items in the list which are not necessities, but it is such a useful one that it

should be provided wherever possible (Fig. 66). The outfit can be purchased complete, but it is very simple to make. The bottle should be a wide-mouthed one, and it should have a capacity of at least a gallon; the rubber tubing should be of large caliber, thick-walled, and of sufficient length to reach easily to any place where it may be used; the stopper of the bottle should be of good rubber; and the tubes which penetrate the stopper should be of strong metal. All connections must be air-tight, of course. The power source may be the high-pressure steam circuit, an electric motor-driven pump, or the water line. For some purposes, where a smaller outfit will answer, a hand pump will furnish enough power. Most operating room nurses will have manipulated the hand outfits on the wards for chest aspirations, etc., and the one needed in the operating room is merely a large and strong edition of the same thing. There are various metal tips made for use on this apparatus and the instrument supply should include one or more of these. See *A* of Fig. 112, page 374, and *J* and *K* of Fig. 116, page 381.

55. **Suits.**—Hospital furnishing houses will supply these operating suits which are made of heavy "twilled" muslin. They will have short sleeves, and the apron (Paragraph No. 3) and gauntlets (Paragraph No. 17), or the gown (Paragraph No. 21) will be used with them.

56. **Suture Material.**—A generous supply of all the following varieties should be kept ready for use:

Plain catgut	Silk thread
Chromic catgut	Silkworm gut
Kangaroo tendon	Silver, aluminum-bronze, etc., wires
Horsehair	
Linen thread	Metal "clips"

The *catgut* is supplied by the market in hermetically sealed glass tubes (Fig. 67), and there are usually seven sizes available, numbered 000, 00, 0, 1, 2, 3, and 4. The numbers 1 and 2 will be more in demand than the other sizes. For those who may wish or need to know how the raw catgut is prepared for use there are various processes given in detail under "Sterilization" on pages 309-314.

Kangaroo tendon may be procured in several weights in the glass tubes.

Horsehair comes in the tubes also, but it is often purchased raw and prepared as indicated on page 308.

The *silk and linen threads*, the *silkworm gut*, the *wires*, and the *clips* are so easily sterilized that they will usually be purchased in the unsterile condition and sterilized as indicated on pages 308-309.

FIG. 67.—FACTORY-PREPARED CATGUT IN HERMETICALLY SEALED GLASS TUBES. *A*, usual form of tube. In this particular sample the suture is wound on a reel. *B*, same kind of tube as *A*, except that it is made wide enough to admit a half-circle needle upon which the suture is threaded.

57. **Syringes.**—There are innumerable types of syringes for all purposes: hypodermics, aspirations, explorations, irrigations, transfusions, etc., and it will be largely a matter of choice as to which kinds will be used.

58. **Thermometers.**—The clinical thermometer will rarely be used, but the bath thermometer should always be ready for irrigations, infusions, etc.

59. **Tongue Forceps.**—The anesthetist will have a choice as to the variety to be provided (see Fig. 41, page 230).

60. **Tourniquets.**—In principle this is a piece of soft rubber tubing about 3 feet long and half an inch in diameter. There are many varieties to be purchased and, as in the case of other instruments, each surgeon will probably have his favorite.

61. **Towels.**—(*a*) *Plain.*—The only point to mention about these towels is that they be of some soft, absorbent material which launders well. Perhaps the best material is that which is known commercially as "bird's-eye cotton." A linen or other smooth surface towel will be found unsatisfactory because it will not stay in place well; instruments slide upon it; and stains of blood, iodine, etc., are not easily removed from it.

(*b*) *Lithotomy.*—This is not a necessity, as a sheet or the wound towels may be used instead, but it is a great convenience and it is so easily made that we recommend its inclusion in the equipment. It consists merely of a double thickness of muslin

about two yards long and 28 inches wide, in the center of which an opening 3 or 4 inches in diameter is made (Fig. 68). This sheet, of course, is turned in and stitched around the border,

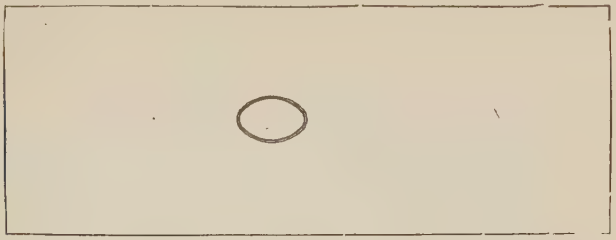


FIG. 68.—LITHOTOMY TOWEL. Made of heavy muslin about 2 yards long and 28 inches wide. The opening in the center is about 3 or 4 inches in diameter. See use of this towel in Fig. 91, page 338.

and the opening should be bound with tape. It is used for draping patients in the lithotomy position, as illustrated in Fig. 91, page 338.

CHAPTER XVI

OPERATING ROOM STERILIZATION

The subject of bacteriology is of tremendous concern in relation to operating room sterilization and, as we have said previously, the student should have studied it before taking up the operating room course. However, for the benefit of those who have not yet covered the subject we shall review briefly here a few of the more important terms which have a bearing upon the contents of this chapter.

DEFINITIONS

Septic.—When we say that a wound is septic we are using a general term and mean that it is under the actively destructive influence of bacteria of some kind, and the word carries with it a special emphasis upon the decomposition caused by the bacteria and its effects. The noun, sepsis, then, would mean the state or condition of being septic.

Infection.—This is a term which is hard to differentiate from sepsis, for when we say that a wound is infected we mean, as we would if we called it septic, that it is inhabited by bacteria which are multiplying within it, are feeding upon it, and are, therefore, destroying its health. In common parlance we use the terms interchangeably, however, and there is perhaps no important difference between them except, as mentioned above, sepsis does bear more of a reference to the products of infection and also to their effects. The term infection is also used in the sense of its being the act or process by which the wound is contaminated with bacteria, and in the sense of its being the bacteria themselves at work in the wound. The use of bacteria-laden hands or instruments, for instance, in a wound would be the act of infection, and the resultant growth of the bacteria in the wound would be the infection itself.

Aseptic.—The term septic, then, with *a-*, which means *not*, prefixed, will mean not septic, or free from sepsis; and the phrase,

aseptic surgery, will signify surgery done in such a way as to prevent bacteria from gaining access to a wound.

Antiseptic.—This same term, with another prefix, *anti-*, which means *against*, will then mean something that is opposed to sepsis, and thus we call anything that tends to prevent or stop sepsis or infection *antiseptic*. We may use it of the system we employ to prevent the state of sepsis or infection from coming about, and thus speak of antiseptic precautions and antiseptic surgery; or we may apply it to the thing that actually stops already existing infection or sepsis, and accordingly call such things as weak solutions of bichloride, Dakin's solution, etc., antiseptics. There are many other agents which will do this, such as heat, strong solutions of bichloride, etc., but the term antiseptic is usually applied only to those which can be used upon the living body.

Disinfectant.—As the term implies, the prefix *dis-* meaning *to deprive of*, a disinfectant is something which removes infection. In its strictest technical meaning disinfectant is properly used to signify only those agents which *destroy disease-producing bacteria*, and only such of those as cannot be used upon the living body; but in everyday practice it is impossible to draw any line of demarcation between our bacteria and so, in everyday speech, we apply the term more broadly and include almost every form of bacteria-removing agent, and even go so far as to call soap and water a disinfectant because, by using them together, we can, though under heavy limitations, remove infection. Thus, we take disinfectant out of the class of destroyers and make it merely a remover, which is perhaps not justice to the spirit of the word, and certainly is not consistent with our other usages of the term when, for instance, we call heat, formaldehyde gas, etc., disinfectants. However, the name is unimportant so long as we know the truth.

Bactericide.—Here, again, our term defines itself. The suffix *-cide* means *destroyer*, and so a bactericide is simply something which can kill bacteria.

Germicide.—As the term implies, a germicide is an agent which *can destroy germs*, or bacteria. In the surgical sense the terms bacteria and germs are used interchangeably, so it does not materially matter which we use here.

Sterilization.—This is really our major term, for it is larger

than all the rest in that it signifies the absolute *destruction of all forms of bacteria.*

Technic.—This is a word which we use a great deal and which often seems to be regarded as the name of something very formidable. It is the name of something very important as it is applied in the operating room, but as is so often the case, this very important thing is, in actuality, a very simple one. Technic is nothing more nor less than *the way of doing a thing*, and in the operating room it is merely the way in which we make and keep things sterile. Even in this sense, however, there is a danger of its becoming something of a bugbear and of its developing into a hindrance rather than the help it is designed to be and always should be. Simplicity is the keynote of good technic, as it is the keynote of all good human endeavor, and the less complex we make it the fewer will be our points of contact with those things which have the power to make it fail.

In the operating room, then, we have all the terms we have just defined as startling watchwords, but the greatest of them are *septic*, or *infected*, and *sterilization*; for we must treat everything that is to come into contact with a wound, either directly or the most remotely indirectly, as though it were septic or infected and must sterilize it before it is used; and, of course, it goes without saying that we must keep it so. Words and their definitions are important, but they will not keep a wound free from infection unless they are put into practice with an intelligence and a conscience, and with a skill that can be acquired only by diligent application.

Much will have been learned in the classroom and on the wards about sterilization, antisepsis, asepsis, and all the rest, and the nurse will know in a general way how to sterilize many things and how to keep them sterile; but *in the operating room she will find a rigidity and a minuteness of technic* which at first will seem to have no relation to what she has previously practiced. On the wards she had to deal only with wounds which were partially healed and which were not, therefore, so susceptible to infection as fresh ones, and for this reason she was permitted many practices which would be very dangerous in the operating room where the wound is fresh and in its most infectible state. Also, in the wards the supplies which she handled were used only on the surface of a wound or within an infected one which is very largely protected from new infection by its

own excretions, while in the operating room she deals with the things that are to come into closest contact with the entire area of a freshly made wound and even with the blood stream itself. Her problem, therefore, is a much more serious one, and her methods must be in accordance. .

THE AGENTS

The subject of practical sterilization is a rather troublesome one to master because of the fact that the various articles needed in surgery differ so widely in composition and therefore in amount and means of sterilization to which they may be subjected without injury. By long experience and practice, however, one or more good methods have been evolved for the sterilization of every substance with which we have to deal, and so our present task is simply to learn, article by article, the special recognized method which is adapted to each individual case. The numerous and somewhat tedious methods may be clarified to some degree for the student if she will learn, as she plods through the details of the following pages, that, after all, *each one may be classified under one of two great classes*, and that whatever particular process she is carrying out is simply an adaptation of one of these two major methods, and that the special variation is dictated by some material peculiarity for which nature is responsible.

These two major classes of sterilizing agencies are, **physical** and **chemical**; and they may be subdivided as follows:

I. PHYSICAL

1. **Moist Heat**
   a. Boiling water
   b. Steam
2. **Dry Heat**
   a. Hot air.
   b. Flame
   c. Actual cautery
3. **Light**

II. CHEMICAL

1. **Washing with Soap and Water**
2. **Solutions of Germicides**
3. **Gaseous Germicides**

I. PHYSICAL STERILIZATION

Of the three forms of physical sterilization moist and dry heat are the only ones that concern us in operating room sterilization because light is not practical there; and of the two forms of heat the moist form is the more effective at a given temperature and period of exposure. Experiment has shown, for example, that boiling water (212° F.) will kill the very hardy anthrax spore in about 12 minutes whereas dry air at a temperature of 300° F. requires almost 3 hours. The moist form is, therefore, more desirable and it is fortunate that by far the greater proportion of surgical supplies may be subjected to it. The reason why the moist form is the more active is a complex one which it must be left to the several sciences involved to explain. Our province here is to point out the practical powers of each which we make use of in our art, and to prescribe the particular one best suited to the sterilization of each of the numerous materials and articles which we employ in aseptic surgery.

1. **Moist Heat.**—*a. Boiling Water.*—This is the simplest agent to use and if it did not destroy, or render unfit for use, so many articles, it would make our entire problem of sterilization a very easy one to solve. Plain water, as you know, boils at 212° Fahrenheit; and, as we shall point out later, in some cases we use enough carbonate of soda (washing soda) in it to make a 1 per cent. solution, which raises the boiling point somewhat. This increase of the temperature of the water, the considerable germicidal power of the soda itself, and the increased solvent power which it contributes to the water, give us an exceedingly valuable sterilizing agent in this soda solution. Laboratory experiments indicate that the boiling 1 per cent. soda solution accomplishes in 2 minutes some of the results for which plain boiling water requires 12 minutes. In addition to its other feats washing soda counteracts the oxidizing or "rusting" power of plain water which is especially valuable for the metal supplies.

b. Steam.—Next to boiling water, steam is our best friend, though the application of it necessitates special and more or less complex equipment. Steam is simply water which has been converted into another form, vapor, by boiling. In its normal state, therefore, it is no hotter than boiling water, and of no more value as a sterilizing agent. It is a physical fact, however,

that if we compress this steam we increase the temperature and its efficiency otherwise, and the more we compress it the higher its temperature becomes; and so it has come about that numerous instruments, "steam pressure sterilizers" (Fig. 69), have been invented in which we can sterilize certain surgical supplies, which are not suitable to boiling, in this compressed steam.

There are many designs of steam sterilizers and no two of

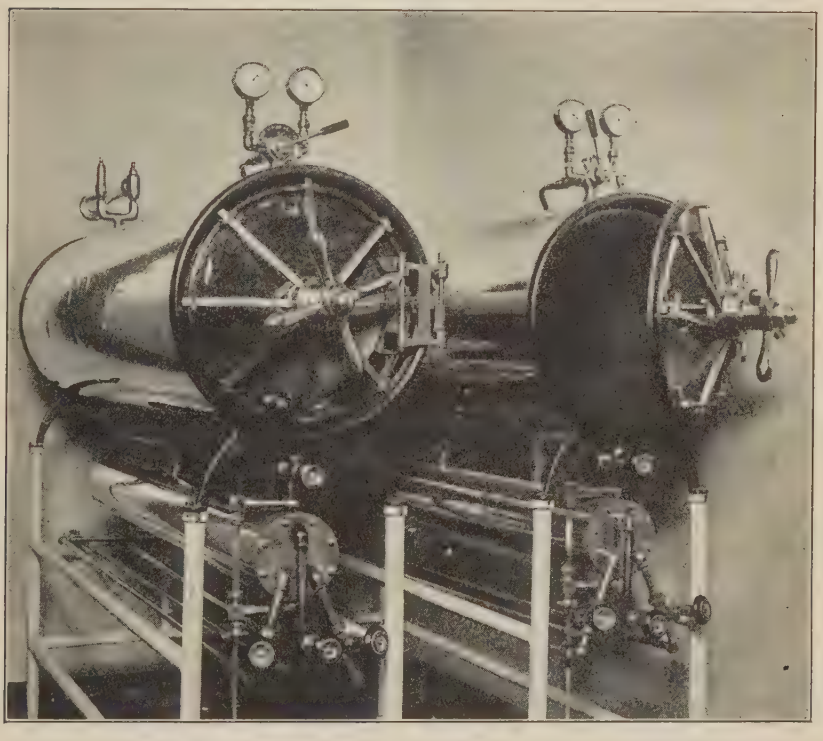


FIG. 69.—STEAM PRESSURE STERILIZER. The construction and operation of this sterilizer are explained on page 286.

them are exactly alike in detail of structure, but they are alike in essential principles, and if we have a clear idea of these general principles we shall have no serious difficulty in learning to operate any particular type that we may encounter. Every operating room student should be faithfully drilled in the actual manipulation of this important instrument, not only because she may have to operate one in her practice after graduation, but

also because the lessons which may be taught by it are perhaps the most important ones the operating room course affords.

At this point we shall stop to study the general *mechanism of the steam pressure sterilizer* so that we shall be prepared to understand more clearly the explanation further on as to why we use it.

Using Fig. 69 as a guide, *this sterilizer may be analyzed as follows:* The large cylindrical part is a strong, hollow, steel shell which contains water, and is called the *"jacket."* Underneath this is the steam pipe, gas burner, or other *heater* which boils the water and converts it into steam. This jacket is, of course, steam-tight, and as the steam increases in quantity it necessarily becomes more and more compressed and correspondingly hotter. The two clocklike dials on the top of the cylinder are *steam gauges* which indicate in pounds the pressure of the steam. One of these gauges is connected with the jacket, and the other we shall speak of presently. At the base of these gauges there are several *valves* by means of which the steam in the jacket may be directed to perform various functions in the sterilizing process. In this particular sterilizer a single lever operates all of the valves. The interior of the sterilizer, into which the supplies to be sterilized are placed, is called the *"chamber."* The door to the chamber is fitted with heavy bolts and a strong locking device whereby the chamber may be made as steam-tight as the jacket. When we have the desired amount of steam pressure in the jacket we open one of the valves just mentioned and allow the steam to enter the chamber where it permeates our supplies. The water is still boiling and giving off steam to fill this new space and in a few moments we have the same pressure in the chamber as in the jacket, as we can tell by the second steam gauge which is connected with the chamber. The jacket and chamber are now in direct communication through the steam valve and we leave them so till we have finished our sterilization. The standard *amount of steam pressure* which is used in these sterilizers is 15 pounds, and at this pressure the temperature of the steam is about 250° Fahrenheit, or 38° F. higher than boiling water. The sterilizer is fitted with a safety valve which is regulated so as to open automatically when more than this amount of steam accumulates and allow the excess to escape. The details as to time of sterilization, etc.,

will be given later on when we discuss the sterilization of individual articles.

This is the A, B, C of sterilization by means of the steam pressure sterilizer and some instruments require no more manipulation than we have just described. When you come to operate one of the more elaborate sterilizers, however, there will be a few more adjustments to make. These will be clearly explained by the manufacturer who always supplies instructions, and it is important that the nurse should have these instructions before her at all times until she thoroughly masters the mechanism of any sterilizer she may need to operate, for the various designs differ in essential details.

A very important feature which will be encountered in all of the better sterilizers is an arrangement for *creating a "vacuum";* and this brings us to a subject which we have not yet mentioned, namely, sterilization by steam pressure in a vacuum. Those of you who have studied physics will know that a vacuum is a space which has nothing in it, not even air, and when we use the term in connection with the sterilizer we simply mean the chamber which has had the air sucked from it; and the "vacuum valve" which you may find on your sterilizer means merely a valve which is so made that it may be turned to allow the steam in the jacket to suck the air out of the chamber. This creation of the vacuum is, of course, done before the steam is allowed to enter the chamber, and we are thus able to sterilize in a vacuum.

The student will now reasonably ask two questions: *"Why do we sterilize in a vacuum?"* and, *"Why, if boiling water is hot enough to sterilize, do we need to heat steam—practically the same thing—to a so much higher degree?"* The answer to the first question is simply that, since by a law of physics no two substances can occupy atomically the same place at the same time, therefore, speaking atomically, where there is air there can be no steam; and as air serves no useful purpose we remove it so that the useful steam may have its place. The answer to the second question is that we do not compress the steam so much to raise its temperature as we do to make it penetrate to the interior of the more or less compact parcels of fabric which constitutes so largely the supplies which we sterilize by this means.

Finally, these sterilizers provide for *the drying* of the supplies after they are sterile, and they accomplish this by sucking out the moisture just as the air was previously sucked out.

Here, we may now point out, is the answer to another question which might arise, namely, "Why not simply boil these supplies since they must become almost as wet in the sterilizer as they would in a boiler, and since they certainly become much hotter?" Both of these things do happen to them, but what cannot happen to them in the boiler is the thorough drying which is a necessity for those things which we sterilize in this way. Another point here is that steam is free from all of the numerous substances such as lime, iron, etc., which are usually found in water; and so, in the steam our supplies escape a considerable amount of soiling and staining from which they would suffer greatly in boiling.

From time to time these *sterilizers must be tested* because there are many ways in which they may become disordered and so fail to sterilize. There are a number of chemical and other inventions on the market which are designed to serve this purpose and some of them are doubtless reliable, but the safest test is an actual culture of some known resistant bacteria, placed in the center of the largest and most tightly packed parcel and subjected to the customary sterilization process. The pathological laboratory will have to be depended upon for the culture and for the bacteriological examination afterward.

2. **Dry Heat.**—*a. Hot Air.*—To sterilize by means of dry air a very high temperature is necessary and it must be applied for a long time, a temperature of 300° F. for one hour perhaps being no more than the equivalent of boiling water (212° F.) for 12 minutes. Relatively few materials will survive this degree of dry heat without being injured to some extent, but there are some cases in which we cannot use any other method.

A *hot air sterilizer* (Fig. 70), in principle, is merely an ordinary baking oven with a few structural refinements added for distributing and equalizing the heat, and when nothing better is available the kitchen oven may be pressed into service. A thermometer is always an important attachment for this sterilizer, and it should be so placed that it will register the temperature of the immediate vicinity of the materials being sterilized.

b. Flame.—Some articles may be sterilized by passing them through the flame of an alcohol lamp or a gas burner. Also, an emergency means of sterilizing the inside of metal or other fireproof basins or dishes is to pour a very small amount of alcohol (methyl alcohol is best) into them, light it with a match, and allow it to burn out. This is a rather dangerous method, and when it is practiced great care must be taken to use only enough alcohol to barely wet the surface of the article, for it burns slowly and with a high degree of heat; pains must be taken not to spill the alcohol anywhere in the neighborhood; and the bottle must be removed to a safe distance before the match is lighted.

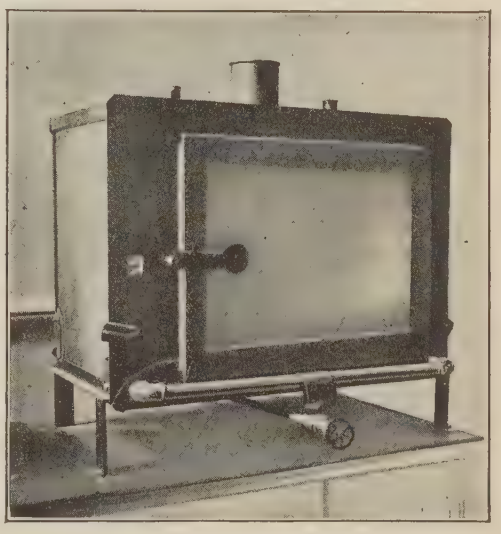


Fig. 70.—Hot Air Sterilizer. The two small vents in the top have corks in them which may be partially removed to aid in regulating the temperature. A long, slender thermometer is fitted snugly into one cork and the tip of this is kept as near as possible to the contents of the sterilizer.

c. Actual Cautery.—The nurse will probably never be called upon actually to use this instrument herself, as its chief applications are for the sterilization of the appendix stump after the appendix has been removed, for the removal of hemorrhoids, or for the cauterization of tumors, ulcers, etc. Its care and preparation for use, however, will be her duty and she should become familiar with it.

The actual cautery may be of one of these three varieties: (*a*) A simple iron similar to *the soldering iron* used by a plumber, and modifications of this for special uses. These may be heated in any flame. The only attention these irons will need to keep them in good condition is to scour them after use with a hard scouring powder (emery, for example) or with a piece of fine sandpaper. (*b*) *The electric cautery* (Fig. 71), for which also there are points of a variety of sizes and designs. (*c*) The

Paquelin cautery (Fig. 72), or one constructed on its general principles. This is a complex instrument which *requires careful handling* to keep it in working order; and as it will usually be the nurse's duty to hand it to the surgeon ready for application

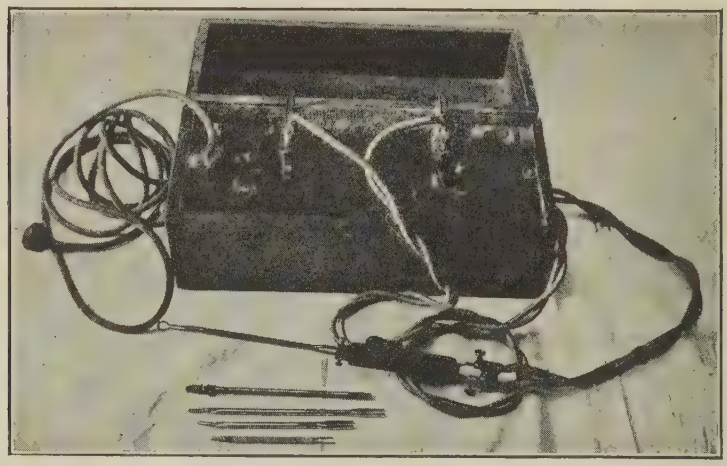


Fig. 71.—Electric Cautery.

every nurse should make sure that she understands it and that she can properly heat it. This cautery consists of a hollow platinum point which is kept hot by the burning of benzine vapor pumped through it from a small reservoir by means of a rubber

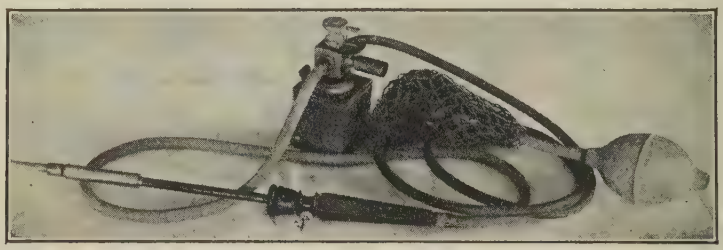


Fig. 72.—The Paquelin Cautery.

bulb. In practice this cautery is often very unsatisfactory because it fails to become or remain hot; but if the hollow platinum point is not punctured, and if its cavity is not obstructed by a dent, its failure is nearly always due to the fact that the person manipulating it does not quite understand how it must be

treated. In the first place, the platinum points are very soft and therefore easily bent or dented, and they must always be handled gently and protected from accident. But given a point in good condition, practically all failures with this cautery are due to the fact that the proper procedure has not been followed in heating it. The benzine reservoir contains a sponge, and in filling it only enough benzine should be put into it to saturate the sponge, for it is only the vapor that will serve our purpose, and if there is more benzine than the sponge will absorb the fluid itself will be pumped into the point and clog it. A good practice is to invert the tank after filling it to allow the excess to escape. The next, and perhaps the most important precaution to be taken is that the platinum point must be heated red-hot (in a gas or alcohol flame) before the benzine vapor is pumped into it. The reason for this will be evident when it is understood that it is the combustion of the benzine vapor within the point that keeps it hot, and if the point is not hot enough to burn this vapor there will simply be an accumulation of condensed vapor within the point which will nearly always obstruct it. The warning, then, is to wait until the point is red-hot and then begin pumping the vapor into it slowly and steadily and to continue thus with the point in the flame for a few moments until the circulation of the benzine vapor is well established. The point can then be removed from the flame and kept red-hot by the steady pumping of the benzine vapor. An important thing to remember is that too much must not be expected of this small red-hot piece of metal, and when large amounts of tissue are to be burned with it the larger points should be used; for naturally, the burning is accomplished by the transference of the heat from the platinum point to the tissue, and if too much tissue surrounds it at any given time it is overcome by having its heat used up faster than it is able to produce it. Thus it often happens that the "fire" in the point goes out during a heavy cauterizing operation, and as soon as this happens the pumping must be stopped and the point reheated in a flame as in the beginning. If the Paquelin point is always treated with the care outlined here it will always respond.

3. **Light.**—Sunlight, of course, ranks high as a germicide, and in your practice of nursing you will see it utilized for infected wounds as well as for other pathological conditions.

Since the germicidal power of sunshine is believed to reside in its actinic, or ultra-violet rays the *electric arc light*, which is rich in these rays, has come into wide use as an indoor substitute for sunshine in a great variety of conditions, both medical and surgical. In the operating room, however, there is no practical application for light as a sterilizing agent.

II. CHEMICAL STERILIZATION

1. Washing with Soap and Water.—Scrubbing with soap, water, and a brush is sometimes classified as a "mechanical" agent. The brush is clearly mechanical, but the soap and water are chemicals, and since these chemicals, in the last analysis, constitute the sterilizing agency in the case, they may very consistently be called a chemical sterilizing agent.

Cleansing with soap and water really deserves high rank among sterilizing agents—not that soap and water in themselves kill germs powerfully, but because *they dissolve and remove* so largely the matter which harbors germs. A thing well washed is not only well on the way to sterilization but it is also in the most receptive state for any of the other agents which may follow because it is so nearly free from all obstructions to their action.

Washing, however, cannot be applied universally any more than can any of the other agents. Circumstances and conditions limit its use. For example, iodine does not penetrate moist skin as deeply as it does dry skin. Therefore, if we wish to sterilize an operative field or an accidental wound with iodine we usually do not use the washing agent unless (as is usually the case with the operative field) we can wash long enough in advance to give nature time enough to absorb the water from the tissues. Also, in cases of infected linen, utensils, etc., safety for handling makes sterilization necessary before washing.

It should be remembered here, of course, that water, as recommended in this connection, must be *running water* and that it must be fresh and clean on its own account. Also, it is not to be taken for granted that soap is sterile. Germs certainly never thrive on or in *soap*, but it is probably a rare soap that cannot act as a *carrier of live germs* for at least a short period of time.

Thus, while soap and water are given recognition among the

sterilizing agents, their limitations and weaknesses must be equally recognized.

2. **Solutions of Germicides.**—Sterilization by means of solutions of germicides is simply the *soaking of articles* in a solution of a chemical, which has the power to kill germs, for the length of time which experiment has proved that each individual chemical requires for a given purpose.

It would be almost impossible to enumerate the various chemicals which have been advocated and used from time to time for surgical sterilization because few of them are entirely satisfactory and new ones are always coming into favor in the hope that the various objections to the old ones may be avoided. There are a few, however, which have stood the test of time and experience, and though individual authorities will always vary in their preferences of even these "tried and true" ones, we are probably safe in saying that the following include the important chemical sterilizing agents which are applicable in general surgery: *Bichloride of mercury, iodine, alcohol, carbolic acid, formalin, Dakin's solution, potassium permanganate, picric acid, mercurochrome, peroxide of hydrogen, Harrington's fluid, lysol, ether, chlorinated lime, carbonate of soda, some of the aniline dyes.*

It would be very helpful to every student if we could now tabulate here the exact strength and time necessary for sterilization in any case by each of these chemicals. Unfortunately, materials, articles, etc., and the chemicals themselves enforce so many limitations upon practice that, often as not, we cannot use either the best chemical, the desirable strength, or the necessary time for perfect results. To mention a few examples, the very potent bichloride of mercury is exceedingly corrosive to so many articles in all strengths, and the equally active formalin is prohibitively irritant to the eyes and respiratory tract of the user in any but the weaker strengths; iodine and potassium permanganate are powerful in concentrated solutions also, but their stain rules them out for so many purposes; alcohol and carbolic acid have comparatively few injurious effects, but they are feeble germicides; and thus one could continue to limit and debar the application of all the other chemicals. The best that can be done, therefore, in a practical way, is to review representative practices. This we shall try to do in the following pages under

"Practical Methods" as articles and materials are considered individually; but it must be remembered in most of the chemical cases there that perfect sterilization (the destruction of resistant spores, at least) is not achieved and that merely the most that is possible under the circumstances is being done.

Warm chemical solutions are more active than cold ones. This is not of much advantage in operating room sterilization because practically the only reason for sterilizing an article chemically is that heat will injure it in some way. However, there are many instances where a moderate amount of heating will be permissible, and in any case, solutions in which articles are being sterilized should be kept in a warm place rather than a cold one.

3. **Gaseous Germicides.**—The application of gases or vapors is called *fumigation.* Though the process is a sterilizing measure it is not of much value to surgery because gases have very little power of penetration; they are inconvenient to handle; and conditions under which they can function with certainty are difficult to establish and maintain. To be effective they require an air-tight chamber, a regulated amount of moisture, elaborate equipment for their liberation, and very free exposure of anything subjected to them. In short, they are not practical for operating room use. Outside of the operating room, however, the nurse will find fumigation used for rooms.

There are many gases which have germicidal power, but of these there are only two which are applicable to the hospital or the home, namely, *formaldehyde* and *sulphur dioxide.* Of these two formaldehyde is now used almost exclusively for germicidal purposes, and the sulphur is used more particularly as an insecticide.

The student will have her lessons in room fumigation processes in her course of instruction in general nursing, and the lesson for her to learn here is that such *fumigation is not surgical sterilization.*

PRACTICAL METHODS

(*For Initial Preparation of Supplies see Chapter XV*)

One of the first principles to be learned by the operating room beginner is to reduce the *handling of sterile supplies* to the very lowest point. The methods we shall give you in the following pages we believe to be perfectly safe and if you follow them

conscientiously we believe your supplies will be sterile, but one must always remember that the human element in all our acts perpetuates the possibility of mistakes and, therefore, every time one avoids handling a sterile thing one escapes a possibility of contaminating it. This applies particularly after the thing is sterile, of course, but one must begin the application of the principle with the packing of the supplies for sterilization because the way in which this is done will determine to no small degree the amount of necessary subsequent handling. The element of time saving also enters here for, on the whole, the more quickly, or, rather, the more directly a sterile thing reaches the wound from the sterilizer the more certain one can be of its asepsis; and so, while we are aiming to avoid frequency of handling we must also aim to reduce as much as possible the duration of each particular act of handling. We should, therefore, pack our supplies in the most convenient and accessible form possible.

Some supplies, such as basins, instruments, etc., will not be packed in advance because they will be awkward to store sterilely. Such things are very simple to sterilize, however, so they present no special problem.

In the following pages we discuss specific practical methods of sterilization and it may sometimes appear that the periods of time given are not consistent with laboratory findings as to the time necessary—that is, for some of the chemicals and for the dry heat our time will be shorter, and for the moist heat it will usually be longer than bacteriologists have determined as requisite. We have pointed out on page 293 the situation we encounter with chemicals, and in the following pages specific explanations regarding them, as well as the other agents, will appear. As for the cases of apparent over-sterilization, we merely do there what we should like to do always, namely, add to the laboratory time a margin of safety to insure our results against error, inexperience, defective apparatus, etc. All reasonable doubt is eliminated from laboratory findings before they are given out, but in the hurly-burly of ordinary operating room practice doubt is ever with us, and because we must understerilize in a few instances is all the more reason why we should make a special effort to balance the account in those instances where we are free to do so. Therefore, if laboratory experiment shows that boiling for 12 minutes is sufficient for some purpose

we are merely cautious, and not inconsistent, if we say that 20 minutes should be the time in the operating room. Materials damaged by over-sterilization may, in a few cases, be a menace in the operating room, but on the whole the inclination to over-sterilize is to be commended in the operating room nurse.

We shall now take up the methods of sterilization of the particular supplies listed on page 257, following essentially the alphabetical order in which they are named there.

Adhesive Plaster.—In rare cases this is sterilized by passing it rapidly over an alcohol or gas *flame* several times.

Bandages.—The gauze and the Esmarch bandages will be the only ones sterilized. For sterilization of the gauze ones see under "Gauze and Muslin Supplies" on page 297. The Esmarch may be *boiled* for 15 minutes, and if it is not often used, or "exercised," the normal salt for the boiling seems to keep it in good condition longer than the plain water. If it is to be stored sterilely it may be drained, powdered with sterile talcum powder, rolled, and wrapped in a sterile cloth cover. At least two of these bandages should be kept in readiness.

Basins.—All enameled ware may be boiled, and the 1 per cent. solution of washing soda should be used for it. At least 15 minutes of vigorous boiling should be given these utensils immediately before use. If convenient, they may be used directly from the boiler; otherwise they may be stored under cover on a table.

Brushes.—These and the orange sticks should be *boiled* in plain water for 20 minutes and then stored ready for use in glass jars containing a 1-60 solution of carbolic acid. Where operations are done only at regularly appointed times these supplies need not be sterilized until immediately before they are needed, but in emergency operating rooms they should be kept ready.

Catheters.—These may all be *boiled* in plain water. For the rubber and the Lisle thread ones the water should be boiling when they are put into it. The rubber ones may be sterilized for 15 minutes, but the Lisle ones will be damaged by more than 3 minutes of boiling. Carbolic acid 1-20 or bichloride 1-5000 is often preferred for the Lisle thread catheters in order to avoid the softening effect of the heat upon them. These solutions are corrosive, however, if applied long enough to be equivalent to

the three minutes of boiling. Also, their mere presence on and within the catheters, as well as the alternative of rinsing them before use, is often deemed objectionable. The method of sterilization adopted, therefore, will be a case of individual judgment as to which drawback is the least objectionable.

Culture Tubes.—The one containing the culture medium will be ready for use as it comes from the laboratory, but the other one will be sterilized in the *steam* sterilizer the same as the gauze supplies.

Dressings.—See "Gauze and Muslin Supplies" below.

Drugs.—Such drugs as albolene, glycerine, olive oil, and vaseline may be sterilized in the *steam* sterilizer if care is taken to put them into containers which will withstand the temperature. They may be sterilized with the dressings but the precaution should be taken of putting them into a tray to protect the sterilizer and other contents from possible spilling. *Novocain* and similar local anesthetic solutions are often not made up till immediately before use when the normal saline is brought to the boiling point, the dry drug added, and the solution allowed to boil for two or three minutes only. Sterilization of the prepared solution in the autoclave for 20 or 30 minutes is also practiced, however.

Gauze and Muslin Supplies.—We shall presume first that you are equipped with the *drums* for these supplies and that you are packing for a session of two or more operations. In this case you will do best to use a set of four drums, and to devote one entirely to each of the following groups: (1) *Gauze sponges, all wound dressings, and a few towels;* (2) *Draping sheets and towels;* (3) *Gowns, or aprons and gauntlets;* (4) *Abdominal pads and towels* (the hot towel drum). Such things as packing, the lithotomy towel and stockings, sterile bandages, cotton, etc., which are only occasionally used, are best packed in individual muslin-covered parcels. Or, for the packing, a convenient plan is to pack it in long glass tubes which are well plugged with cotton and wrapped in a muslin cover. One doctor's suit or gown, a cap, and a mask are best packed together in a parcel for each individual according to size; likewise, there should be a similar set of cap, gown, and mask for each nurse, as these articles will be needed in the dressing rooms, and but once for a session. When the gauntlets are used a supply of rubber

bands, safety pins, or some other device for holding them in place should be packed with them.

If drums are not used about the only substitute will be the *muslin-covered parcels*, and when preparation is made for several operations to be done at one time the general plan given above for the drums will work well. However, with the parcels there will always be more handling required in opening and disposing the contents upon tables, and for this reason it may be better to combine them into fewer numbers. How this is done must be left to the ingenuity of the nurse who will be guided by her equipment and the nature of her work; but she must always keep in mind her goal of simplicity and minimum amount of handling and exposure.

In small operating rooms, where only one operation need be prepared for, one drum or one parcel may be used for all these supplies except, of course, the individual wearing apparel, which should be arranged as in the other cases.

For all parcels of sterile supplies *at least two layers of cover* should be used and they should be put on separately—that is, a finished parcel, including the pins, should be made with the one cover and then the other should be put on in exactly the same way so that it will be closed on the same side of the parcel as the inner one. Proceed this way: Select two covers, each of which is large enough to overlap generously on the top and ends of the parcel; spread them out, one over the other, on a table, place the supplies on top, and then fold and pin the first cover securely over the top, not turning the parcel meantime; then fold and pin the second cover in the same position as the inner one. This gives the same base to the parcel for the two covers, which will be safe and convenient in opening it. Only straight pins may be used for a parcel of this kind, and all but the heads of them must be buried because otherwise an unsterile part of the pin may be drawn through the sterile interior of the parcel. Safety pins are very clearly ruled out on this ground.

Do not crowd things together too closely in a drum nor compress a parcel too tightly. Make it as easy as possible for the steam to penetrate into every nook and corner. It may be a temptation to economize in space, but space saved at the expense of sterilization is not permissible economy.

All of these supplies are *sterilized in the steam pressure steri-*

lizer, and they should be exposed to the steam at 15 pounds pressure for 45 minutes, and to the drying process for from 20 to 30 minutes or more, according to the load.

Gloves.—The gloves, first of all, should be carefully *tested* to eliminate those with the slightest perforation (see page 352). They are then *powdered* well and evenly on both sides with talcum powder; the *cuff turned up* over the outside for about two inches; and placed in the muslin *covers* (Fig. 58, page 264), if these have been provided, and otherwise folded in a towel. If the towel is used it should be so folded about the gloves that a layer of it comes between them for this will aid in permitting the steam to reach all parts. It is best technic to provide a separate cover for each pair; and with each pair should be included a small *packet of talcum powder*, as the hands will need to be well powdered before attempting to put on the gloves. This powder is best wrapped loosely in a piece of thin paper.

These parcels of one pair each are then packed together in a drum or muslin cover, enough pairs being provided for accidents such as tearing or unsterilizing. A few towels should be included in this parcel for use in drying the hands.

It is a good practice, before sterilizing new gloves for the first time, to *scrub them well and boil them* for a few minutes, as otherwise some brands will come out of the first sterilization covered with an objectionable gummy substance. The scrubbing and boiling not only prevents this but it also makes more certain that the gloves have had a clean start otherwise.

Gloves are *sterilized in the steam sterilizer* at 15 pounds pressure, and they can never be subjected to the steam for more than 20 minutes without greatly injuring them. They should never be packed tightly because, at best, parcels of gloves offer much resistance to the penetration of the steam. Drying should be accomplished inside of 20 minutes also, and if loosely packed 10 or 15 minutes will suffice. Rubber does not withstand high temperature well, and if damaged in sterilization gloves are easily torn and may then be as much of a menace as when imperfectly sterilized; for it must be remembered that the hands are never considered absolutely sterile. This is the *"dry method"* of glove sterilization.

Some surgeons will prefer *"wet sterilized" gloves*, and in that case the gloves are boiled for 15 minutes and then stored in a

basin of some antiseptic solution from which they are used directly. The particular solution used will be a matter of preference but it will probably be either a 1-1000 or 1-5000 solution of bichloride of mercury, 1-60 carbolic acid, or lysol ½ per cent. or 1 per cent. The advantage of gloves used in this way is that the hands remain wet with the solution and are doubtless more nearly sterile than they are with the dry gloves, and an accidental puncture is more likely to be harmless; but the dry ones are more extensively preferred because they are more comfortable and they avoid the complication of sore hands which sometimes is an annoying accompaniment of the practice of using wet gloves.

As in the case of all boiling of rubber, the gloves must not be put into the water till it has reached the boiling point because they deteriorate somewhat at best in the hot water; also, only plain water must be used, as for all rubber, and never the soda solution.

Another point requiring attention in boiling gloves is to see that they are filled with the water and do not float on the top of it. *A glove which is collapsed or floating in the boiler does not become sterilized* on the inside. When it is collapsed the inner surfaces are adhering and they receive no treatment except that of the heat which the rubber itself conducts from the water which is on the outside, and since rubber is a poor conductor of heat the inside of these gloves is cheated out of even as high a temperature as that of boiling water, to say nothing of the benefit of the moisture. In the case of a floating glove there is air locked within it, and air is another poor conductor of heat as well as of moisture. Also, in this case, the part of the outside of the glove which is above the water receives no benefit from the boiling except the almost useless amount contributed by the steam confined by the lid of the boiler—if, perchance, the boiler has a lid.

A hint which it may be well for the nurse to pick up here is that old rubber which has lost its "life" may be somewhat rejuvenated by boiling it for a few minutes in a weak (about the normal) solution of salt.

Gutta-percha Tissue.—This should be cut into pieces of various sizes, ranging from 3 to 8 inches square. It should be washed in soap and water before sterilizing, but care must be taken to

use cool water because hot water dissolves it entirely and warm water softens and wrinkles it. The only method which can be used for sterilization of gutta-percha is the chemical one and the best solution is *bichloride 1-1000.* You may feel that by this method you are not sterilizing the tissue beneath the surface since it is impervious to any solution, but when you soak it over night, or for 12 hours, you may feel that your germicidal solution has reached any part of it that any of the wound fluids will be able to do and that, therefore, it is fit for aseptic surgical use. Necessarily, this tissue is prepared in advance, and after it has been subjected to the 1-1000 solution of bichloride for 12 hours it should be stored in a glass jar in a 1-5000 solution of bichloride. Do not use a stronger solution than the 1-5000 for storage because the tissue is used directly from this solution and a stronger one will be irritating to some wounds. Also, do not use a carbolic acid solution because gutta-percha deteriorates rapidly in it. This tissue is sometimes inaccurately called "rubber" tissue. Gutta-percha resembles rubber considerably but it is a different substance.

Hypodermoclysis and Infusion Outfits.—These will be combinations of metal needles, rubber tubing, and either a glass or an enameled metal irrigator, or the rubber stopper and glass tubes device. In any case, there will be assembled three kinds of material (rubber, glass, metal) each of which is best sterilized differently from the others. It is impossible, therefore, to devise an entirely satisfactory way of sterilizing these outfits, particularly if one wishes to keep them assembled and stored sterilely. Needles are liable to rust in sterile storage after any sterilization process except the hot air one, and rubber cannot be subjected to the hot air process. However, if the outfit is used frequently, so that the needles and the rubber can be inspected sufficiently often, the complete outfit may be wrapped in a muslin cover and *sterilized in the steam sterilizer.* As the parcel will not be a compact one, half an hour under the 15 pounds of pressure, with the same drying period, should thoroughly sterilize and dry it. It would not be over-cautious in this case, perhaps, to *boil the rubber tubing separately* for 15 minutes and drain it carefully before putting it through the steam process. It can be so handled that the interior will not be contaminated, and the measure will compensate for whatever doubt one may have as

to the circulation of the steam within this long and slender piece of soft rubber tubing which may have become kinked in packing or handling.

Another plan which some persons find satisfactory is to *sterilize the parts separately* as follows: The needles in glass tubes by the hot air process as advised on page 304 for the syringe needles; the rubber tubing by boiling, draining for a moment by the use of sterile forceps, and wrapping in a sterile towel; the irrigator or stopper device in a muslin cover in the steam sterilizer. One should, of course, be "scrubbed up" to assemble this for use. If the outfits are sterilized only when needed they will be boiled, and the rubber's maximum time of 15 minutes is all that can be given if the parts are assembled.

Inhalers.—All parts which come into contact with the patient must be *washed and sterilized* because disease bacteria which inhabit the respiratory tract may easily be transmitted by inhalers. Metal parts can be boiled for the maximum time in the soda solution, and the rubber parts can be boiled in plain water. An alternative method for the rubber is a 1-60 carbolic acid solution, but in the long run the boiling will not do the rubber any more harm than an equivalent exposure to the carbolic. In boiling the re-inhaling bags care must be taken to have them filled with water and fully immersed during the process because the interior surface is the more important one to have thoroughly sterilized and if it is collapsed, or if there is air locked within it, the boiling will be of little or no avail in these unbathed parts. Another precaution is advisable with the pneumatic face pieces: These should be partially deflated before boiling because they will sometimes burst from the expansion of the air when it is heated.

Instruments.—All instruments except the "cutting" ones and those with parts which heat will damage are *sterilized by boiling* in the 1 per cent. washing soda solution for 15 minutes. The sharp-edged ones are somewhat dulled by the boiling and, therefore, are sometimes sterilized chemically, though boiling for 3 minutes is often practiced also. Knife blades and all other sharp instruments which do not have their own shields should be wrapped in cotton or gauze to protect them from injury during sterilization.

For the *chemical sterilization* 70 per cent. alcohol, 1-20 car-

bolic acid, 5 per cent. formalin, etc., are used somewhat but the objection to solutions is that they must be applied so long (if they are to be of much use) that the water which they all contain rusts the instruments more or less. The 5 per cent. formalin should be applied for not less than 30 minutes, and the alcohol and carbolic acid for at least an hour or two. Well plated instruments should survive two hours, and even longer. Instruments should always be unlocked and taken apart as much as possible before being placed in solutions because otherwise tight locks, hinges, etc., receive no treatment whatsoever. All chemically sterilized instruments should be well rinsed in sterile water before they are put on the instrument table.

For all sterilization in alcohol the 70 per cent. solution should be used because it has been proved to be more efficient than the concentrated solution. The reason for this does not seem to have been definitely determined but it is believed to be due either to the drying effect of the stronger solution upon the bacteria or to its formation of a resistant coating upon their surface.

Another method occasionally used for sharp instruments is to soak them in 95 per cent. carbolic acid for 5 minutes, rinse off the carbolic in alcohol, and then dry them. Rust is avoided in this way but great care is needed to make certain the removal of the carbolic from intricate joints and crevices.

In any of these solutions the disadvantage of rust may be greatly reduced by the addition of *a few grains of borax* which is a specific against the oxidation of metal. Borax is not a germicide but it is something of an antiseptic.

The *hot air method* is sometimes used for the sterilization of instruments, and for the heavier and plainer ones there seems to be no harmful result, but the practice will play havoc with the delicately constructed and cutting ones as the high degree of temperature necessary and the subsequent cooling alter their adjustment and their "temper."

Irrigators.—These will be of either glass or enameled metal and both may be either *boiled* or wrapped in a muslin cover and *sterilized in the steam sterilizer* the same as the dressings. In all boiling of glass it is necessary, if one would avoid eventual disaster, to wrap the article in a cloth cover, or at least to lay it on a cloth pad of some kind, because the jarring caused by vigorously boiling water may easily result in breakage by col-

lision with the boiler or its other contents. It probably does not need to be added that glass articles must be put into the boiler before the heat is turned on.

The glass irrigator may also be sterilized by the hot air method.

Needles, Suture.—These may be *boiled* with the instruments, for although they come under the classification of cutting instruments, which we have said are usually not boiled, the harm done to them is so little as to be negligible. In some large institutions where many varieties are needed during a session it is the practice to arrange a complete set in a muslin or folded towel case (Fig. 73) and sterilize them in a cloth cover in the *hot air sterilizer* for 1 hour at 300° F. This softens them somewhat, but in the judgment of some surgeons the entire avoidance of rust and the convenience compensate for this slight objection.

Needles, Syringe.—These may be *boiled*, and for special purposes, such as local anesthesia, distilled water will be used (for reason see page 315, under "Syringes"). Since any moist method of sterilization will rust the interior of steel needles in time, a good plan is to put each one into a small glass tube plugged with cotton and *sterilize it in the dry air sterilizer* for 1 hour at 300° F. Needles treated in this way will always be free from rust and will last much longer. At all times, whether sterile or unsterile, and particularly during sterilization, all syringe needles must have stylets in them if they are to be kept clean and open.

Rubber Dam.—This is used chiefly for drains, usually the "cigarette" drain (A of Fig. 105, page 358), which means simply a piece of rubber rolled around a strip of gauze after the fashion of a cigarette. It is the better practice not to make up drains till immediately before use as the size will need to be adjusted to each individual wound, so you will simply need to have the rubber dam in readiness in a variety of sizes of from 3 to 8 inches square. The pieces should be well washed with soap and warm water, and then *sterilized by boiling* in plain water for 15 minutes. This rubber will be in better condition for use if boiled freshly at the time, but when it is used frequently it is a good practice to boil a supply in advance and store it in a well-covered glass jar in a 1-60 carbolic solution. This solution softens the rubber in time so no more should be prepared than will be used within a week, at most.

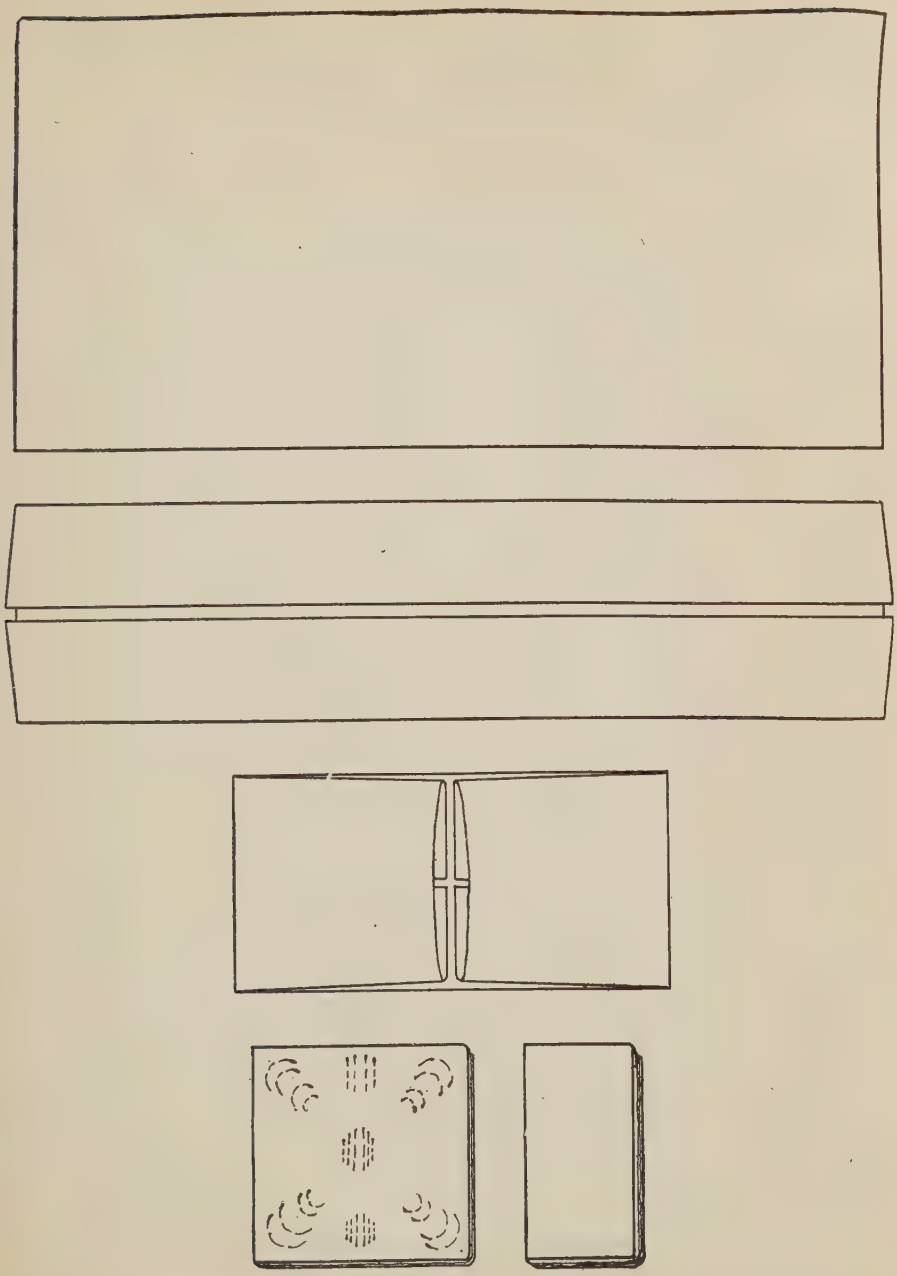


FIG. 73.—NEEDLE BOOK. Made from the ordinary draping towel or a piece of muslin folded by the steps indicated.

Rubber Sheets, Etc.—As advised before, only the all-rubber sheet should be used in the operating room because the cloth-reinforced ones cannot be satisfactory sterilized. However, if this combination of cloth and rubber is used as sheets, aprons, etc., it may be *soaked in a 1-60 carbolic acid solution* for several hours. This will apply also to the Kelly pad. Do not put rubber sheeting into bichloride because there will be a chemical reaction between it and the sulphur usually mixed with the rubber which will render the bichloride very largely inert. A previous scrubbing with soap and water is taken for granted, always. A good quality of this sheeting will survive the *steam* sterilizer two or three times. It should be well powdered with talcum powder, laid between two pieces of muslin or gauze, then folded and wrapped loosely, and sterilized at 15 pounds pressure for about 15 minutes. The gauze or muslin layers serve the triple purpose of minimizing cracks at the folds, preventing surfaces from sticking together injuriously, and of facilitating the penetration of the steam. The all-rubber sheets may be *boiled.*

Rubber Tubing.—Whether or not you provide a sterile supply of rubber tubing will depend upon how much demand you have for it. Some surgeons use it considerably for drainage, and in that case it is well to have a sterile supply prepared in advance. Tubes of a variety of diameters will be needed, and a serviceable length for each piece will be about 12 or 14 inches. After being well washed this rubber may be prepared for use in one of several ways: It may simply be *boiled* for 15 minutes and then stored in a jar of 1-60 carbolic acid solution; or, after washing it may be boiled, dried, powdered, and sterilized in muslin covers or long glass tubes in the *steam* sterilizer. The reason for boiling this tubing before steam sterilization is the same as that given above for rubber gloves, namely, to prevent the oozing to the surface of a troublesome amount of gummy substance which will otherwise occur under the steam. The powder serves the same purpose as in the case of the gloves, namely, to absorb the small amount of this gum which will always appear under the steam. Before use this powder must be rinsed off in sterile water. Perhaps the most practical plan for storing this tubing is in the long glass tubes which are sold as "catheter" tubes. One piece in a tube will be best, and a gauze-covered absorbent cotton stopper fastened well down over the

mouth of the tube will be necessary so as freely to admit the steam to the interior.

Salt Solution.—(*a*) *Concentrated.*—As advised above, this is a 10 per cent. solution which has been prepared in glass flasks. The flasks should be wrapped in a muslin cover as it will be convenient to have the outside of them sterile. They are best *sterilized in the steam sterilizer* in the same way as the gauze and muslin supplies, and if packed carefully they may be done at the same time.

(*b*) *For Infusions.*—The infusion salt solution should be *sterilized by the fractional method*, which means that it must be done three times at 24-hour intervals, and between sterilizations it must be kept in a warm place (at about 99° F. if possible). The process each time will be the same as for the other salt. The reason for this special treatment is to encourage the development of any possible spores during the interval and thus bring them into a form which will be sure to succumb to the next sterilization. Special care must be taken to see that these flasks are tightly plugged with non-absorbent cotton as otherwise the water will evaporate considerably in the course of these three sterilizations and render the solution too concentrated. A precaution to be taken in starting the sterilization of tightly stopped flasks and in opening the sterilizer afterward is to raise and release the pressure in the chamber very gradually because otherwise the flasks are likely to burst; or, if the flasks have more resistance than their stoppers the stoppers will be ejected and much of the solution will follow them.

Suture Material.—Some of the glass tubes (Fig. 67) of catgut and tendon may be *boiled*, but the contents of others are injured by heat. Those which cannot be boiled are usually so marked by the manufacturer. If permissible, boiling should be the method of sterilization, but it should be done with care because the tubes sometimes explode in the sterilizer and if many are being boiled together the explosion of one may be followed by the loss of many others. Wrapping compactly in a cloth cover is one precaution to take, and starting with cold water is another.

In a large and busy operating room a reserve supply of these tubes should be kept sterile. If they can be boiled for 20 minutes they may be stored in a 1-60 carbolic acid solution. If *chemical sterilization* is necessary a more active germicide should be used,

such as 1-1000 bichloride or 5 per cent. formalin. They should be allowed to remain in these solutions for 12 hours before being handled as surgically sterile. If used directly from these solutions they must be thoroughly rinsed in sterile water before they are taken to the operating table. It is perhaps better practice to pour off the bichloride or formalin after the 12 hours, rinse the jar and contents well with sterile water, and use a 1-60 carbolic solution for the storage.

Horsehair will usually be used from the prepared tubes which can be *boiled* and stored like the catgut tubes. Home preparation is sometimes practiced, however, and it should be done thus: Several hours of soaking in soap and water should first be given it and then it should be thoroughly washed with soap and running water. It is then rolled into coils as suggested below for the silkworm gut, sterilized by boiling in clear water, and stored in a 1-60 solution of carbolic acid. Because of the special danger of tetanus and anthrax spores in the case of horsehair, sterilization of fresh supplies must be very thorough, an hour being advisable. The horsehair will withstand this amount of exposure to boiling and there is, therefore, no reason for giving it less. Alcohol is sometimes used instead of carbolic for storage, but this is likely to make it too stiff and somewhat brittle.

The *silk and linen threads* should be wound loosely on small reels, preferably glass ones, and it will be more practical for future use to leave them in one long piece rather than to cut them into suture lengths. If they are white and it is desired to dye them black any standard fast dye may be used. They are best *sterilized by boiling* in plain water and they should not be subjected to the process for more than 30 minutes or they will be damaged somewhat. They may then be stored in 70 per cent. alcohol. The "Pagenstecher" may be treated in the same way. Sometimes the silk thread may be impregnated with paraffin or with liquid albolene. When paraffin is used it should either be first melted and the silk then boiled in it, or a jar containing the silk and enough of the paraffin to cover it when melted may be placed in the autoclave and sterilized like the gauze dressings. When boiling paraffin over a flame or a stove it must be closely watched as it will burn if allowed to become too hot. Albolene, also, may either be boiled or sterilized in the autoclave, and it

will need the same care as the paraffin when boiled on a stove or open flame.

The raw *silkworm gut* will usually be supplied by the market in bundles of 100 strands each about 14 or 15 inches long. These may be wound in coils of one or more strands each by rolling around the fingers into a circle of about 1½ inches in diameter, the end of the strand being wrapped around the finished coil to prevent its unrolling (Fig. 74). Silkworm gut is usually sold in the natural color, white, and if it is preferred black it may be dyed as suggested for the silk and linen. This is best done after it has been rolled into the coils. It is then *sterilized by boiling* in clear water, and, unlike the silk and linen, it does not deteriorate in boiling, so a generous amount of time may be given it—at least 30 minutes. It should then be stored in a 1-60 carbolic acid solution. Alcohol should not be used for this storage, as silkworm gut has a tendency on its own account to be brittle and alcohol will encourage this tendency too much. Some lots of raw silkworm gut will be inclined to crack and splinter when rolled into the coils. In this case it should be soaked in water for an hour or two, which will render it very pliable.

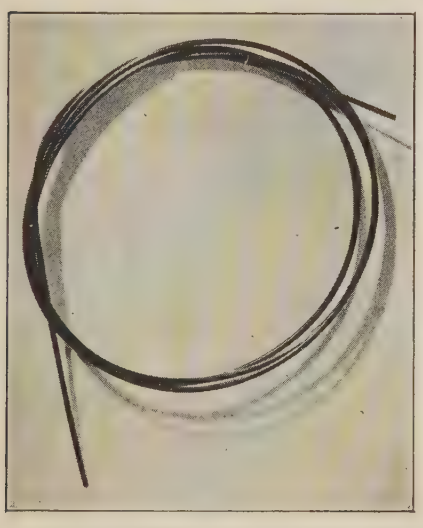


Fig. 74.—Method of Rolling Silkworm Gut, Raw Catgut, etc. The ends should be coiled about the roll only once or twice as more turns will permanently kink it.

Silver, aluminum-bronze, and other *wires*, and the *metal clips* may be *boiled* any length of time in plain water. Since they are so easily sterilized it is not necessary to keep a sterile supply of them ahead.

Sterilization of the raw catgut will probably not be done in many operating rooms, but for the occasional case and for reference purposes we give here a few comments on the subject.

When the nurse undertakes the sterilization of suture material she must remember that she is dealing with the most *serious piece of sterilization* which she will ever be called upon to do because the sutures, especially the catgut ones, are imbedded in tissues which have been more or less injured by the operation and thereby made more susceptible to infection, and they will hold there in this very good culture medium any bacteria or spores which may have escaped destruction, and thus bring about the most serious kind of infection. Tetanus germs, in particular, are known to inhabit catgut. Some sterilization methods are easy enough to carry out in that they consist merely of soaking the catgut in a germicidal solution, but where heat is used great technical skill is required to produce a suture of good quality. Usually the several steps in the formulæ, especially those involving time and temperature, will be found to be so delicately balanced that the slightest error of technic or defect of apparatus will be disastrous. Before attempting the sterilization of catgut, therefore, one must make sure that she understands and can control her sterilizer and all other apparatus, and that she realizes clearly the purpose of each step in the process. A very important point to be settled before each sterilization is that the thermometer used is accurate because a faulty thermometer will betray the most refined technic. The person who does this work must give her undivided attention to it throughout the process.

The raw catgut is manufactured in many weights, seven at least, and is usually sold in bundles of ten strands, each strand being 10 feet in length. There are many *ways of arranging it before sterilization* and most of them are convenient and technically good, but the one which will apply to all methods is that of cutting it into the proper size for use, which will mean about 30 inches for the suture and 15 inches for the ligature, the strand of 10 feet thus making 4 sutures or 8 ligatures. These should then be rolled into coils as suggested on page 309 for the silkworm gut. The most economical way is to roll each suture or ligature separately, but any number which is found convenient may be combined into one coil. This plan involves so much less handling after sterilization than those in which it is necessary to cut the desired piece from a large reel, and this is perhaps the best reason one can advance in favor of any method of sterilization.

There are many *formulæ for the preparation of catgut* and they differ widely. We give below a few representative ones.

Lee Method (Modified).—

1. Line metal or glass beakers loosely with heavy filter paper, so as to insulate the catgut from the walls of the beaker which gets hotter during the process than the contents and will burn the catgut at any point of contact.
2. Throw coils of catgut into beaker loosely.
3. Place in hot air sterilizer.
4. Raise the temperature of the oven slowly to 212° F. and keep it there for 40 minutes. This is to dry out the catgut, and it should therefore be done on a dry day and in a room free from abnormal moisture.
5. Immediately at the end of the 40 minutes barely cover the catgut with liquid albolene which has been heated to about 120° F.
6. Raise the temperature of the sterilizer slowly and gradually to 300° F. and keep it at exactly this temperature for 30 minutes.
7. Leave the beakers in the sterilizer to cool slowly.
8. After 24 hours heat the sterilizer slowly again to 300° F. and keep it there for one hour.
9. Allow to cool as before.
10. When cold drain off the albolene and store the catgut in sterile jars in a 1/16 per cent. alcoholic solution of iodine.
11. The catgut will be ready for use in 24 hours.

It will be better not to cover the beakers during the process, which will be perfectly good technic since the sterilizer is not disturbed during the 24 hours. Of course, sterile forceps will be used for transferring the catgut from the beakers to the sterile storage jars.

Bartlett Method.—

1. String the coils of catgut on a thread.
2. Suspend them in glass or metal beakers from a cardboard or other cover so that they will not touch the beakers at any point. The reason for this is that the beakers become hotter in the process than their contents and the catgut will be burned wherever it touches the beaker.

3. Insert the thermometer into the center of the beaker through an opening in the cover.

4. Put the beakers in a sand bath and raise the temperature (within the beakers) to 180° F. and keep it there for 1 hour; then raise the temperature gradually to 220° F. and maintain it there for 1 hour more. This is to dry the catgut.

5. Pour on enough liquid albolene to barely cover the catgut.

6. Heat very slowly, during a period of 1 to 2 hours to 212° F. and keep it at that temperature for 12 hours.

7. At the end of 12 hours increase the heat slowly, through a period of 1 hour, to 300° F.

8. When 300° F. is reached immediately turn off the heat and allow the temperature to decrease to 212° F.

9. Drain off the albolene and store the catgut in sterile jars in a solution composed of:

Iodine crystals	1 part
Columbian spirits	100 parts

10. The catgut is ready for use in 24 hours.

Claudius Method.—

1. Place the catgut in a jar of this solution:

Iodine crystals	1 part
Potassium iodide	1 part
Distilled water	100 parts

2. Cover the jar tightly and let it stand for 8 days.

3. After the eight days the catgut may either be left in the above solution or stored in alcohol.

4. Rinse the catgut in sterile water before use.

Burmeister Method.—Soak the catgut for one week in this solution:

Chloroform	1 gram
Metallic iodine	15 c.c.

Boeckmann Method.—

1. Soak catgut in ether for 1 week.
2. Wrap in paraffin paper and seal in a paper envelope.
3. Sterilize in dry air sterilizer at 300° F. for 3 hours.
4. Repeat sterilization after 24 hours.

New York Hospital Method.—

1. Soak in benzine 24 hours.
2. Allow benzine to dry off.
3. Boil in alcohol for from 1 to 1½ hours, according to the weight of the catgut.
4. Leave catgut in the alcohol.
5. After 24 hours boil again for ½ hour.
6. Store in alcohol.

Great care must be taken when boiling alcohol to do it always in a double boiler or sand bath, as alcohol is easily ignited, especially when an open flame is used.

Chromic catgut is merely plain catgut which has been *hardened* in a solution of chromic acid to make it resist absorption in the tissues longer.

The chromicizing must be done before the catgut is sterilized and before the long strands are cut. The reasons for this will be found in the following facts: (*a*) The chromic acid is made up with water which renders the catgut spongy and which must be dried out of it before anything further can be done; (*b*) in the process of drying there is a certain amount of shrinkage which takes place very unevenly unless the strands are kept stretched during the process; (*c*) consequently, the strands must be stretched out at full length across a large frame or between two wall pegs, and securely fastened at both ends under moderate tension for drying; (*d*) it is easier and simpler to handle the long strands than the short ones for this part of the process.

Therefore, *to chromicize the catgut* we lay the rolls as they come from the factory in a dish which will allow them to lie loosely on the bottom without cramping, and then pour over them a 1-2000 chromic acid solution, and leave them undisturbed in this solution for 24 hours. At the end of this time we remove one strand at a time and stretch it carefully and at an even and moderate tension across the frame or between the pegs, fastening both ends securely because there is considerable shrinkage in drying and therefore a strong pull on the ends. The strands may be separated without difficulty if the precaution is taken, before putting them to soak, to examine the roll, as one would a skein of yarn, to see in which direction it may be unwound, and then to place it in the jar accordingly. It is left on the

frame until "bone-dry" and is then *sterilized like the plain catgut.*

Syringes.—Most syringes for general use are boilable, and *boiling* for 20 minutes in plain water is the best method where permissible; but there are so many types that one must make sure of the construction of each one before attempting to sterilize it because the wrong method will quickly put this delicate instrument out of order. An all-metal one which has perhaps a leather or rubber plunger or packing, a hard rubber one or one with hard rubber mountings, and some of the combination glass and metal ones cannot be boiled and must be sterilized by soaking in some solution. A 5 per cent. formalin solution or 70 per cent. alcohol can be used for those which do not have leather or rubber parts, and a 1-20 carbolic solution is about the only one left for the leather and rubber. The alcohol and carbolic should be applied for an hour or two and the formalin for at least 30 minutes. A plan which may be applied to the all-glass one, where it will be an advantage to have it ready-sterilized, is to put it (with the plunger and barrel separated) into a cotton-plugged glass tube and sterilize it in the steam sterilizer. Foresight should be used in putting the parts into the tube so that they may be taken out without unnecessary handling. This is especially advisable for the small hypodermic syringe which may be used by an unsterile person. A piece of cotton will be needed in the bottom of this tube to prevent breakage, and the mouth of it should be covered with a cap of gauze so that it will remain sterile. A cloth cover may be used, of course, instead of the glass tube.

In all syringe sterilization *plunger and barrel must be separated.* The most important reason for this is that the syringe is probably not sterilized if it is not done because plunger and barrel fit so closely that the water, steam, or chemical solution never reaches the surfaces which are in contact. Other reasons are the practical certainty, otherwise, of breakage of the combination metal and glass ones through the greater expansion of the metal plunger than of the glass barrel when heated, and the possibility of troublesome adhesion of plunger and barrel. There are a few syringes which are disordered by the separation of plunger and barrel, and they are usually so constructed that they cannot easily be taken apart. The best one can do with these is to draw the sterilizing solution into them, immerse them

thus, and give them plenty of time. Such syringes, however, will not often be found in the operating room.

In some cases, such as local anesthesia, *distilled water* will be used for the boiling of the syringes to avoid the danger of a reaction through the introduction into the blood stream of foreign substances borne by undistilled water.

Thermometers.—The *chemical method* will always be necessary for the sterilization of thermometers. This is a case in which no harm can result from chemical action, so complete sterilization is possible, and a thoroughly washed and rinsed thermometer should be surgically sterile after soaking for 12 hours in 1-1000 bichloride or 5 per cent. formalin. Wherever practicable, as it is in this instance, a thorough rinsing in alcohol or ether should follow the washing so as to eliminate all probability of soap being carried into the sterilizing solution. After sterilization the thermometers should be well rinsed in sterile water and stored in a sterile towel. Several should be kept ready for use so that there will be no need for slighting sterilization.

Tourniquet.—This may be *boiled* for 15 minutes (assuming that it is of soft rubber), and when it is not frequently used, or "exercised," normal salt solution for the boiling seems to keep it in good condition longer than plain water. If it is to be stored sterilely it may be drained and wrapped in a sterile cloth cover. Several tourniquets should be kept in good condition.

All parcels of stored sterile supplies should be kept *free from dust* and the dry ones must be *protected from moisture*. The cleanest and dryest place in the operating theater is the place in which to keep these supplies. They should all be carefully *labeled* and the *date of their sterilization* should be marked upon them. The date is really a very important item in the label because, in addition to its being an indication of age, it is a safeguard against accidental use of an unsterilized parcel.

CHAPTER XVII

THE OPERATING ROOM IN ACTION

PREPARATION OF THE ROOM FOR THE OPERATION

It would be impossible for anyone to suggest a practical order of procedure for the "setting up" of an operating room which could be followed in all detail in any two rooms, but a technical order would be virtually as follows:

1. Adjust doors and windows so as to *exclude dust and prevent draughts,* and *regulate the temperature* of the room at about 75° or 76° F. This applies also to the anesthetizing room.

2. See that the *rooms* and all their equipment are as *clean* as soap and water can make them.

3. Put to *soak all articles which must be sterilized chemically* long enough in advance so that they will be ready to handle and use when that is desirable.

4. See that the cold *sterile water* tank contains plenty of water that has been entirely cooled, and that the hot sterile water tank is supplied with plenty of water that is boiling hot. This item is placed near the top of the list because if these boilers have been forgotten considerable time will be necessary to put them into condition.

5. Inspect the *dressing rooms* to make sure that they are clean and in order, and that the brushes, soap, hand sterilizing solutions, etc., are there and ready for use.

6. See that the *operating tables and stretchers* are prepared for use with pads, pillows, sheets, blankets, straps, etc., that they are in their proper places, and that all table attachments are in working order and in their assigned places; also, that instrument and dressing tables, and all other articles of furniture are suitably arranged.

7. See that there is the necessary supply of adhesive plaster, bandages, safety pins, etc., in a convenient place; that cautery, suction apparatus, etc., are ready and in working order; and that floor basins, linen hampers, etc., are in their proper places.

8. Unless it is customary for the anesthetist to do it, see that the *anesthetizing room* is supplied with the necessary anesthetics, inhalers, mouth gags, tongue forceps, towels, and any other items which are provided for it.

9. See that the *utensil and instrument sterilizers* are filled with water and that the washing soda has been added. If the basins, etc., have not been previously put into the utensil sterilizer they should be put in now and this boiler started. These supplies will be needed in the final preparation of the room and should be sterilized well in advance. If there is a *hot towel drum,* see that its base is filled with water.

The points at which we indicate that sterilizers should be turned on have no technical significance, of course, because sterilizers heat at widely different rates. They need to be included somewhere in the enumeration, however, and the intention is to have everything fully boiled not more than five or ten minutes before it will be used.

10. Distribute the parcels and drums of sterile supplies, including the wearing apparel to the dressing rooms. If parcels are used for the room-draping sheets and towels a good plan will be to put them in a group on a stretcher or an operating table in the center of the room rather than to have them scattered about on chairs, etc., where an unnoticed intruder may unwittingly unsterilize them. After these parcels are opened they must be guarded, and one can guard a single location with greater certainty than she can two or three.

11. Turn on the heaters for the instrument sterilizer and the hot towel drum. As stated above, times for starting heaters are placed where they are here merely to recognize the detail, but after one knows the habits of her several sterilizers, and if she is systematic, she will give each one an appointed place in her order of procedure so that its contents will be ready for use just a few minutes before they are needed.

12. Dust all of the tables and other pieces of furniture which are to be sterilely draped, or otherwise used for sterile supplies, with towels wrung out of some germicidal solution such as 1-1000 bichloride or 5 per cent. formalin. If you have an unsterile assistant she may do this for you while you are scrubbing up. It is sometimes done by the scrubbed-up nurse who merely changes her gloves before doing the draping, but this is not a technically good

practice because it exposes the gown to many risks of being unsterilized. This dusting is in no sense a sterilizing measure, and a careful nurse with hands and gown merely clean can replace the dust in the case with a film of antiseptic solution to as much avail as can a scrubbed-up nurse. Out of consideration for the hands, especially if formalin is used, one should wear gloves for this work.

13. If you have no assistant, unpin and lay open the room-draping parcels far enough so that you can reach the interior after your hands are sterilized, leaving the contents as much protected as possible. This step will be omitted, of course, if another person can open the parcels for you after you have scrubbed up.

14. Scrub up. First of all you will *put on your cap and mask,* as you cannot do it safely after your hands are sterile and no one else can do it satisfactorily for you. Next, *scrub your arms and hands* by means of a brush, green soap, and warm running water, scrubbing from the elbows downward and continuing the process carefully and painstakingly for at least 5 minutes (10 minutes is often the rule), taking special care to clean thoroughly about the nails many times with the nail cleaner. There should be a timepiece in the dressing room and this scrubbing should be continued for the full time "by the clock," because many of the bacteria which we are aiming to remove from our hands by the process lie embedded in the deeper layers of the skin, around the hair follicles, in the sweat gland ducts, around and under the finger nails, etc., and we must give the soap and water the element of time which is necessary for all chemical action. The brush and orange stick are good mechanical helpers for the soap and water if used without too much force; use them continuously during the process, but remember that their function is to help remove dirt and not true skin. The scrubbing completed, rinse off the soap very thoroughly, allowing the water to run from the hands toward the elbows, rather than in the opposite direction, so as to avoid the possibility of rinsing contamination from the unwashed upper arm downward over the hands. Then you will subject the hands and arms to some germicidal solution, or perhaps several of them. Prescriptions for this part of the process are many and diverse. Here are several possibilities:

a. Put a small quantity of chlorinated lime and the same amount of powdered washing soda into the palm of your hand, make a lather of this with a little water and rub the arms and hands with it for two or three minutes; then rinse this off in a basin of sterile water and immerse the arms and hands in a 1-1000 solution of bichloride for 3 minutes.

b. Soak in half-strength or three-quarters-strength tincture of iodine for 3 minutes and then rinse in alcohol for the removal of the iodine.

c. Soak in a saturated solution of potassium permanganate for 2 minutes, then in a saturated solution of oxalic acid until the deep purple color of the potassium permanganate has entirely faded.

d. Rinse in alcohol, or alcohol and ether, and then immerse in a 1-1000 solution of bichloride for 3 minutes. When bichloride is used the greatest care must always be taken to have absolutely all of the soap removed because bichloride will not penetrate it and, therefore, will not reach the skin beneath it. This alcohol and ether step is designed particularly to complete the removal of the soap and should not be slighted.

There are many other procedures which you will encounter from time to time and it should be remembered that, whatever the method, it cannot be followed too faithfully because the hands are very difficult to sterilize. In fact, they are never regarded as surgically sterile, hence the major reason for wearing rubber gloves.

The hands being thoroughly prepared, you now put on the sterile gown, having some unsterile person fasten it for you, and you are ready to go into the operating room.

The hands must be dried at some stage, of course. To avoid dripping the solution from them over other sterile supplies a towel can be packed on the top of the gown and the hands dried before handling the gown. A technical objection to this, however, is that there is danger of unsterilizing the towel against unsterile clothing while using it. With care, however, either objection can be avoided and the point at which the hands are dried can be a matter of choice. In any case, this towel should not be handled more than is necessary, and certainly the hands should not come into contact with the part of the towel which has been used on the arm in the neighborhood of the unsterilized

part. It is possible, and quite simple with practice, to perform the entire act of drying both hands and arms by keeping the hands under either end of the towel without changing their original grasp upon it. Thus they need never touch a used part of the towel which is, of course, ideal. When wet gloves are used the drying of the hands naturally does not enter into the case.

15. Put on the *rubber gloves* and whatever other articles of sterile wearing apparel may belong to your system. With the dry gloves there will be sterile talcum powder provided, and one of the chief secrets of avoiding a struggle in getting one or more of the finger tips into place is the application of this powder profusely to every part of the hands, particularly the fingers. In putting on rubber gloves one of the most sternly forbidden errors of technic is to touch the outside of the glove with the bare hand. The cuffs of the gloves have been turned up over the outside for two or three inches before sterilization. This should be done for either the wet or the dry method of sterilization, and the gloves may then be put on thus: Grasp the first glove near the fold of the cuff, and on the palmar side, and keep that hold without shifting as you pull the glove over the other hand. Gloves should not be so tight that the hand will not go in by pulling from this joint only. Leave that cuff as it is. With the gloved hand now pick up the second glove by passing the tips of all the fingers under the fold of the cuff—again on the palmar side—assigning the thumb to a position well removed from the opening of the glove, and pull this one on without changing your grasp upon it. Each cuff may then be turned down over the sleeve without touching any part which has been in contact with the bare hand. Practice this with a pair of unsterile gloves. It very easily becomes automatic.

After one's hands have been gloved they must be very carefully guarded. A good technician always holds her unoccupied hands in front of her, away from her gown, and slightly above elbow height; and when waiting longer than a few minutes for the operation to begin she covers them with a sterile towel just as she would an exposed instrument tray or dressing table. The warning against touching the gown with the gloves is really a very important one. If we are careful we can keep our eyes, as well as our minds, on our gloves and thus know when they

are unsterilized, but watch as we may we cannot possibly have the same assurance that our gowns have not touched some unsterile object in passing.

16. *Drape the tables* with the sterile towels or other covers and put upon them the sterile supplies which you know you will need or which it is customary to have within easy reach. In draping tables it is a good practice to cover them first with towels wrung out of some germicidal solution, such as 1-1000 bichloride, 5 per cent. formalin, or even sterile water, because the wet towels stay in place better than the dry ones, and in any case more than one layer of draping should be used on a table on account of the possibility of unnoticed holes in a cover.

Another technical point to be observed in laying a cover across a table is to place it properly on the front edge of the table first and then pass it slowly and evenly backward, keeping its edge lying over the gloves so that the under side of the sheet, and not the gloves, will run the risk of striking a near-by wall or the back of the unsterile table. Sterile sheets and towels should never be shaken about nor tossed hurriedly into place because dust is raised in this way and, also, a swiftly moving sheet is too likely to strike something unsterile and unobserved.

There are so many details involved in the arrangement of the various supplies, and systems are organized so diversely that it would be futile for one to undertake to particularize further as to how an operating room should be set up. Have a system that is the safest one you can devise, and then never cease trying to make it safer and simpler.

We shall now assume that you are ready for the patient.

The *anesthetizing room,* where possible, should be so *closed off from the operating room* that the patient will not be subjected to the sometimes distressing sight of the ominous preparation which has been made for him. Our operating rooms may be things of beauty to us but they will not impress our unfortunate and lonely patients that way, and a good nurse always keeps her patient sheltered as much as she can from reminders of his plight. Of course, when the operating room must serve also as the anesthetizing room this cannot be managed.

What you do next will depend somewhat upon the anesthesia.

The nurse's part in the induction of the various general anesthesias, and her preparation for the local ones, have been discussed in Chapter XIV so that can be assumed here. Sometimes the nitrous oxide, ethylene, and ethyl chloride will be administered before the sterile preparation of the patient and sometimes the draping will be done first. In some cases of regional anesthesia there will first be sterilization and temporary draping of the site of the injection, particularly when the anesthetic is injected at a site which is not within the operative field—in spinal anesthesia, for example. However, with the exception of a few details, the type of anesthesia will not affect our procedure in the major subjects which we shall now take up, namely, the *sterilization of the operative field,* the *arrangement of the operative position,* and the *sterile draping* of the patient.

PREPARATION AND STERILIZATION OF THE OPERATIVE FIELD

Regularly, the first step in the preparation of an operative field is *shaving,* and this is by no means a minor part of the preparation. Hair is even more difficult to sterilize than skin, and any that remains on an operative field is almost certain to retain bacteria there with it. A clean shave, therefore, is the first treatment, and to this end are necessary a sharp razor and the utmost thoroughness in using it. All shaved areas should be traversed two or three times, and the general direction for drawing the razor should be against that in which the hair naturally lies, because if drawn with the inclination of the hair it will leave long stubbles in its wake and often it will glide over fine hair without even cutting it. A part which needs special attention in shaving is the umbilicus because the hair there is often fine and concealed, and since the umbilicus is within or near the field of most of the major abdominal operations it can be a serious menace in those cases if not properly prepared.

In most cases the shaving will be done on the ward, but the operating room must also be prepared to do it occasionally. *If iodine is to be the sterilizing solution* shaving done on the operating table should be "dry" because iodine does not penetrate wet skin readily and, also, it is believed by some that the presence of an abnormal amount of water in the skin renders it more

susceptible to the somewhat irritating effect of iodine. Sometimes when iodine is used as a routine operative field sterilizer soap lather is permitted for shaving if it can be used twelve hours or so in advance of the iodine. In any case, after the use of soap, great pains must be taken to remove it by repeated rinsing with water, and if the skin is not broken and will permit it otherwise, alcohol or ether, or both, or a mixture of the two should be used freely to complete the elimination of the soap.

There is perhaps no entirely satisfactory method of sterilizing an operative field and as a consequence it is done in a variety of ways. Also, the part of the body to be sterilized, the age of the patient, the condition of the skin, etc., require variations from time to time within any system adopted. The following are some of the methods used:

The *field is scrubbed* well with soap and water immediately after the shaving, and as long as twelve hours before the operation if possible. The *soap is rinsed off* thoroughly with water, then with alcohol or ether or both, and a sterile towel is then applied to remain till the patient reaches the operating room. On the operating table a coat of *iodine is applied*, allowed to dry well, and is then left on during the operation or is sponged off with alcohol before the draping is done. Often the full-strength tincture of iodine (7 per cent.) will be used, but a three-quarters-strength or a half-strength alcoholic solution of it is also used, particularly for old people and children.

Sometimes the field will be painted with half-strength tincture of iodine immediately after the scrubbing on the ward, a sterile dressing will be applied, and then another coat will be applied in the operating room.

With a view to keeping the skin dry, *benzine* is often used as the cleansing agent instead of soap and water, a scrubbing with ether administered to remove the benzine, and then the iodine is applied. This method is especially useful in emergency cases because the need for preliminary cleaning is usually great there and benzine is a good substitute for soap and water in any case.

A simple way *to apply iodine* is by means of a small gauze sponge held in a pair of long sponge forceps. In all iodine application care must be taken not to use so much that it will trickle down under the patient's body, into the axilla, over the

perineum, or any other part where it may be confined in the presence of moisture and cause troublesome burns.

Such parts as the face, perineum, etc., as a rule are not subjected to the iodine and will be cleansed by one of the scrubbing methods.

Other solutions used occasionally for painting the operative field are a 5 per cent. solution of *picric acid, mercurochrome,* and some of the *aniline dyes* such as gentian-violet, brilliant green, malachite green, acriflavine, etc. Like the iodine, the stain left by these solutions is an advantage in the assurance it gives that no part of the field has been slighted in the treatment. *Carbon tetrachloride* is also used somewhat.

Bichloride 1-1000, and *Harrington's fluid* are also used for bathing the field after scrubbing, especially in those parts of the body where iodine and the other staining solutions are not suitable, and occasionally a wet dressing of 1-5000 bichloride will be used during the interval between the ward preparation and the operation.

OPERATIVE POSITIONS AND DRAPING

It is something of an art to arrange the patient in a good and stable position and to place the sterile draping so that it will be unobtrusive and at the same time serviceable and durable. Anyone can lay towels and sheets around an operative field, but it takes study and ingenuity to do it well. Likewise, there are many points about the various positions which, to be appreciated, must be studied and practiced carefully.

A very important lesson to be learned before undertaking to arrange operative positions is that of *the mechanical structure of the operating table* and the manipulation of its adjustable parts. Many tables are rather complex in their mechanism but every attachment and adjustment serves some helpful purpose if understood and used properly, and the operating room nurse will avoid much confusion and inconvenience in her department if she sees to it that she is master of all the intricacies of this very important article of her equipment.

In all cases of local anesthesia special effort must be made to *make the patient as comfortable as possible.* A softer pad (a mattress, perhaps) should be used on the table; small pillows should be used freely wherever they will give support or com-

fort; sufficient covering to suit the patient's feelings should be applied; if rubber sheets or sandbags are necessary a towel should separate them from the patient's skin; and so on, the patient being the final authority (outside of surgical necessity) as to whether or not he is comfortable.

We shall now take up the representative operative positions and the sterile draping suitable for them. If not definitely mentioned it will, of course, be understood that *the operative field has been sterilized* immediately after the position has been arranged and before the sterile draping is adjusted.

Also, as it will be monotonous to mention it each time, we

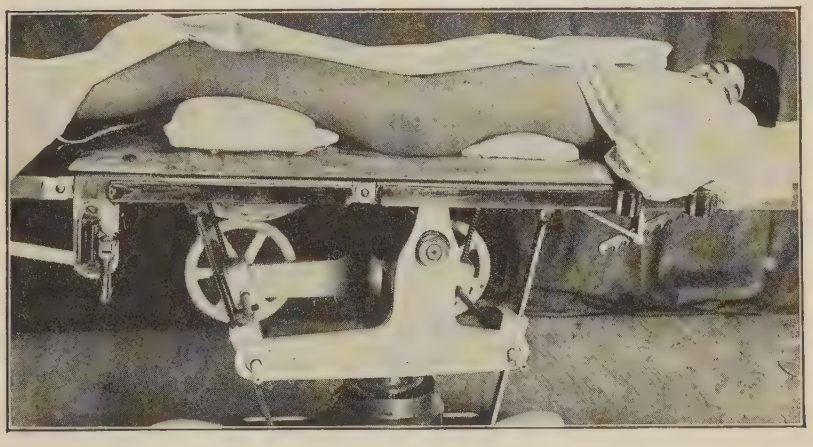


Fig. 75.—Dorsal Position. The pillows under the back and thighs are for the greater comfort of the patient and for the relaxation of the abdominal muscles.

shall here lay down the rule that *a rubber sheet will be thrown over the patient, table, sandbag, etc.,* in any place where there is likely to be much drainage from the operative field.

Dorsal Position.—This is the most frequently employed position (Fig. 75), and it will be *used for most operations upon the intestines, stomach, pancreas, spleen, and bladder.* In some cases the patient is simply placed flat upon the back, but in others there will be a small pillow under the "small" of the back and a larger one or a small sandbag under the thighs as shown in the illustration. *The pillow under the back* will be especially desirable for women, whose backs naturally curve more than

men's, and it *will serve the purpose of preventing the severe backache* which so frequently complicates convalescence from a long abdominal operation, because it keeps the muscles of the back in their natural position and prevents the abnormal strain which would otherwise occur. *The pillow under the knees causes relaxation of the abdominal muscles* which results in much less strain upon them and thus enables the surgeon to retract them out of his way more easily and with less injury to them when doing an abdominal operation. The arms may be arranged in

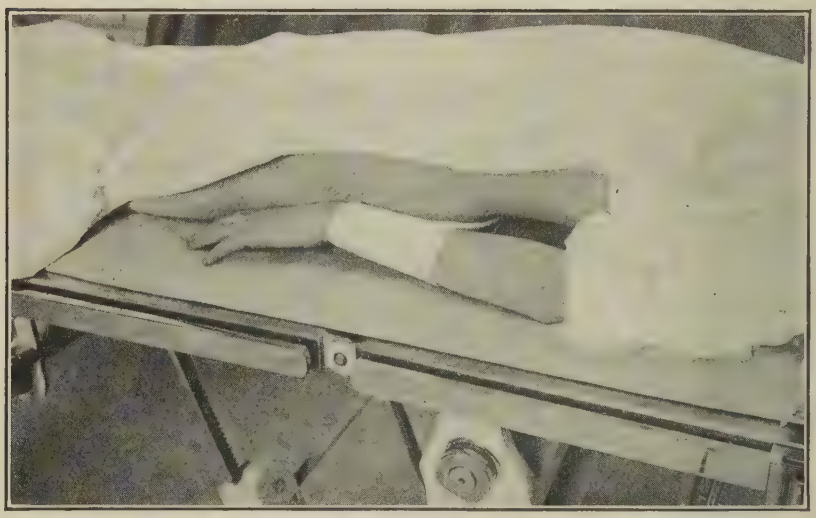


FIG. 76.—METHOD OF FASTENING THE ARMS AT THE PATIENT'S SIDE. The towel is passed under the patient's body crosswise of the table, and the end is carried around the wrist and then tucked under the body.

various ways but these two will answer all purposes for this position: (*a*) They may be fastened at the patient's side by means of a folded towel (Fig. 76), which is passed across the table under the patient's back and an end either pinned about each forearm, or turned over each arm and then tucked under the patient's body. (*b*) They may be laid against the chest with the hands well outward on the shoulders (Fig. 77), the sleeve pinned to the shoulder of the gown, and the tail of the gown tucked about them to hold them in place. The arms are less obtrusive, as a rule, when lying at the patient's side, but there are many operations in which this practice is technically unrefined, for instance, in abdominal or other trunk cases in

which pus, irrigating solutions, etc., may run down over the arms and hands thus placed.

The position established, *the operative field is now sterilized, and for this there will be a simple draping* with sterile towels so placed as to protect the sponge and the gloves from unsterile sheets or table fixtures. The field sterilized, these towels should be left undisturbed because they cannot be removed without danger of contaminating the field.

The sterile draping for this position is relatively simple and is done in one of two ways: (*a*) *The laparotomy sheet* described on page 275 is laid over the patient very carefully (Fig. 78),

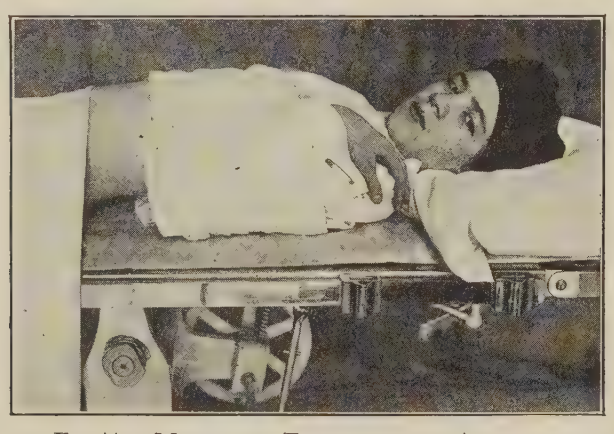


FIG. 77.—METHOD OF FASTENING THE ARMS ON THE CHEST. The sleeve of the gown is pinned well outward on the shoulder, and the tail of the gown is then brought up over the arms and securely tucked under the patient's body.

two people being almost necessary for this act in order not to run the risk of dragging the sheet over the patient and thus unsterilizing it underneath in parts which may later be drawn up into the operative field. There are several ways in which this sheet is sometimes folded before sterilization so that one person can apply it, but they require a great deal of time, and as there is always more than one person sterile for any operation where this sheet will be appropriate an assistant can always be found; or, if carefully done there can be no objection to an unsterile person handling the end which is placed at the patient's head because this is unsterilized immediately in any case. (*b*) *Two sheets and 4 towels* may be arranged as in

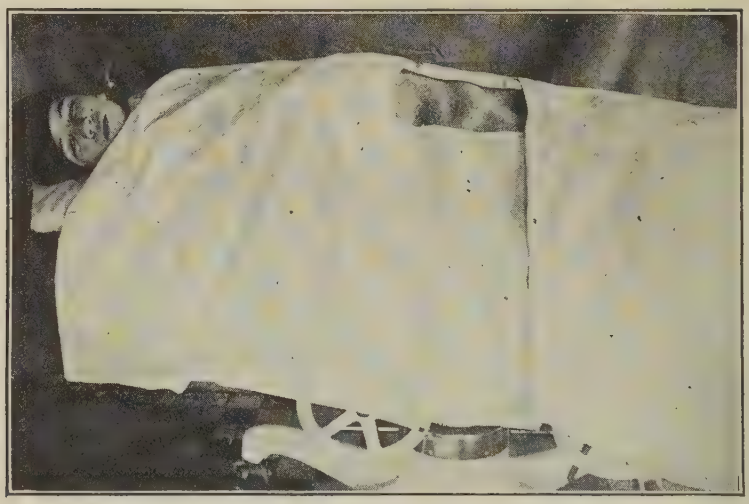


FIG. 78.—LAPAROTOMY SHEET IN PLACE FOR AN ABDOMINAL OPERATION. If the opening in the sheet is larger than necessary for the particular case this sheet may be supplemented with towels as shown in Fig. 79.

FIG. 79.—DRAPING FOR THE DORSAL POSITION WITH TWO SHEETS AND FOUR TOWELS. One sheet is laid across the lower part of the table and the edge brought up to the lower border of the operative field, and the other over the chest similarly. The towels are then disposed over these as illustrated, the crosswise towels lying on top of the lengthwise ones for greater security. One of the towel clamps shown in Fig. 107 binds these towels and the underlying sheets securely together at each corner of the operative field.

Fig. 79. It should be noticed that the towels which run lengthwise of the patient are put on first and the crosswise ones laid over them, because this is the much more secure way and it brings the towel edges into positions where they will be less likely to cause annoyance by catching upon instruments or by being brushed out of place by the arms of the surgeon and assistants. The two crosswise towels will keep the draping in place much better if they are wet, but if the operative field has been painted with iodine there may be objections to the use of wet

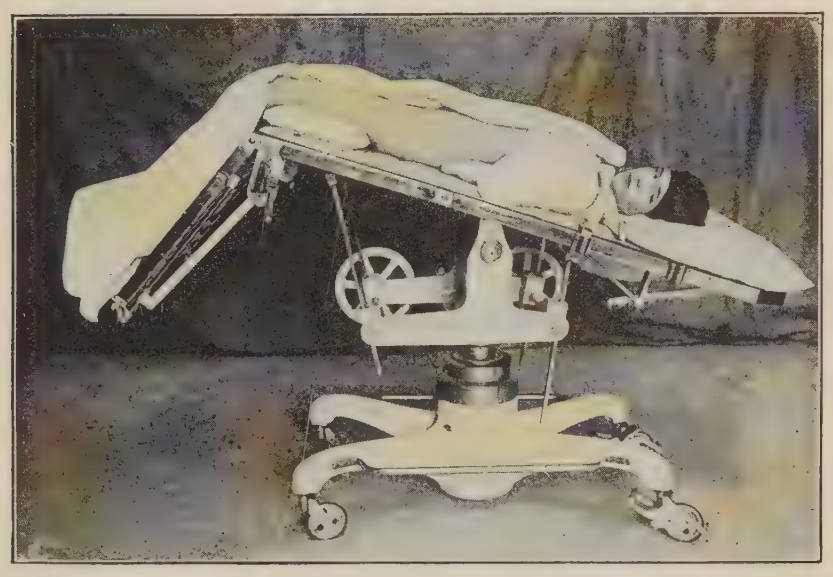


Fig. 80.—Trendelenburg Position. The pillows under the patient's back and thighs serve the same purpose as in the dorsal position (Fig. 75). The shoulder guard, shown more clearly in Fig. 81, keeps the patient from sliding.

towels here. A towel clamp (B or C of Fig. 107) or some substitute, such as an ordinary artery clamp, will be needed at each of the four corners of the field to keep the draping in place.

Trendelenburg Position.—For this position (Fig. 80), the patient is first placed in the dorsal position, the foot section of the table is dropped, and the whole table top is then inclined, with the foot upward, at an angle of 45° or less, care having been taken to have the patient's knees exactly opposite the hinge of the footpiece. It will be necessary to have the patient braced in some way at the shoulders so as to prevent his slipping down-

ward. All the better tables will have shoulder guards (Fig. 81) for this purpose, but in their absence sandbags will serve well, or the shoulders may be lashed to the table with a strong bandage.

The pillows under the back and knees will serve the same purpose here as in the dorsal position. *The hands and arms* will be arranged as for the dorsal position.

This position will be used in *gynecological or other pelvic operations* as it causes the intestines to gravitate out of the way

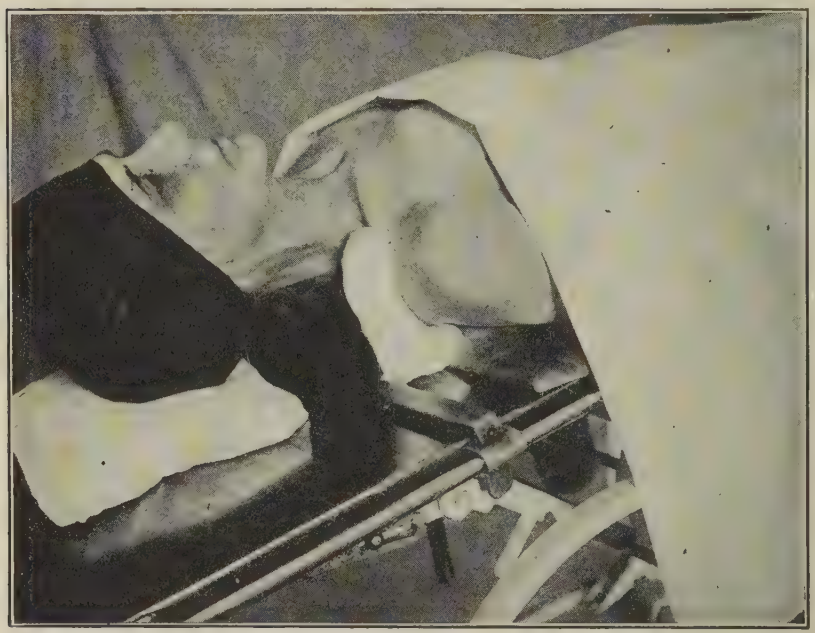


Fig. 81.—Shoulder Guard. This is one of the usual metal kind which has a cotton pad bandaged on it. This or some other pad should always be used on these guards for thin patients and for all conscious ones.

and also brings the pelvic contents up from the bony cavity in which they would otherwise be more or less inaccessible.

The draping is the same as for the dorsal position.

On page 467 is illustrated a method for *improvising this position* when without the convenience of the special table.

Gall Bladder Position.—In some cases the dorsal position will answer for operations upon the gall bladder, but oftener the

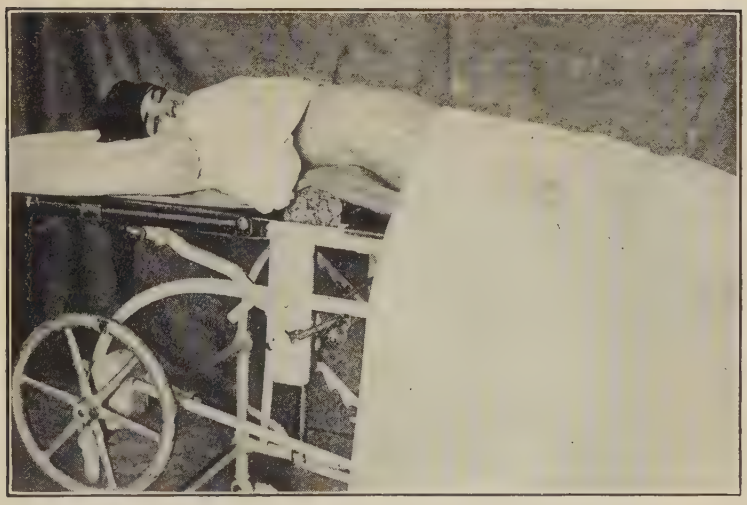
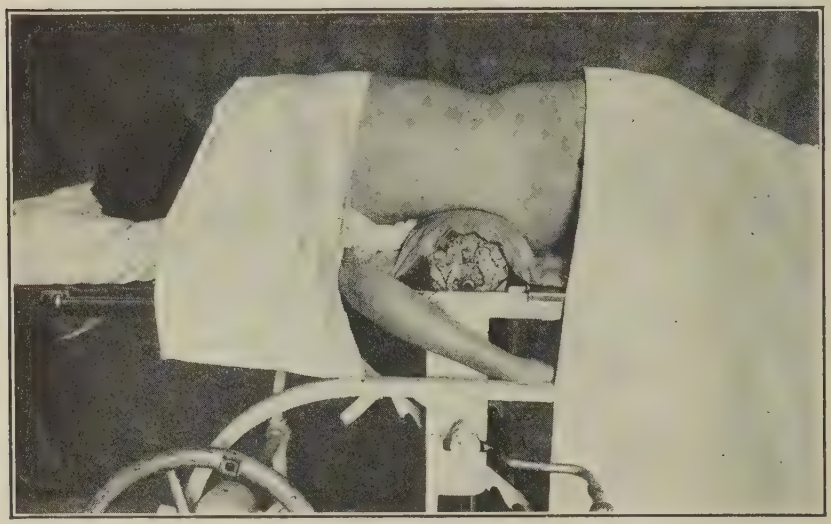


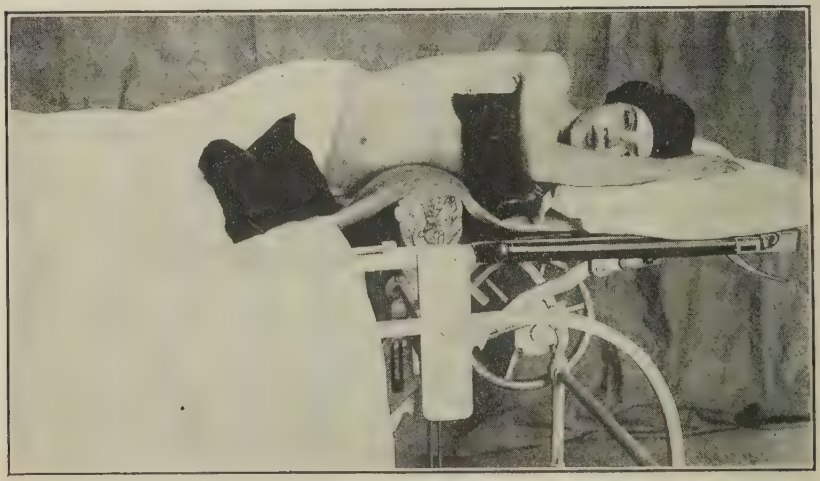
FIG. 82.—GALL BLADDER POSITION. This table has a crosswise rest which may be screwed up under the gall bladder region so as to throw it well upward. In lieu of this a small sandbag will serve the purpose. See also Fig. 83.

FIG. 83.—GALL BLADDER POSITION. This particular table can be broken under the gall bladder region so as to accomplish the purpose of the rest shown in Fig. 82.

region will have to be thrown upward (Fig. 82) so as to bring the organ out from under the ribs. If your table is not supplied with the "rest" shown in the illustration a pillow or small sandbag will answer the purpose; or, you may have a table which



A



B

FIG. 84.—KIDNEY POSITION. *A*, rear view showing the disposal of the one arm and the elevation of the patient's waist line to about the level of the hips; *B*, front view showing where the other arm rests and how the sandbags are best placed for stabilizing the patient in the proper position, which is slightly forward of the true lateral position.

can be broken in the middle directly under the gall bladder region (Fig. 83) which will accomplish the same purpose.

The draping will be the same as for the dorsal position.

Kidney Position.—The patient is turned on his side (Fig. 84) with the lower arm at his back, the other up toward his face, the uppermost knee and hip joints flexed so as to bring the knee down upon the table in the capacity of a brace to keep the body from falling forward, the chest is braced anteriorly with a large sandbag, and sometimes the pelvis also will need the support

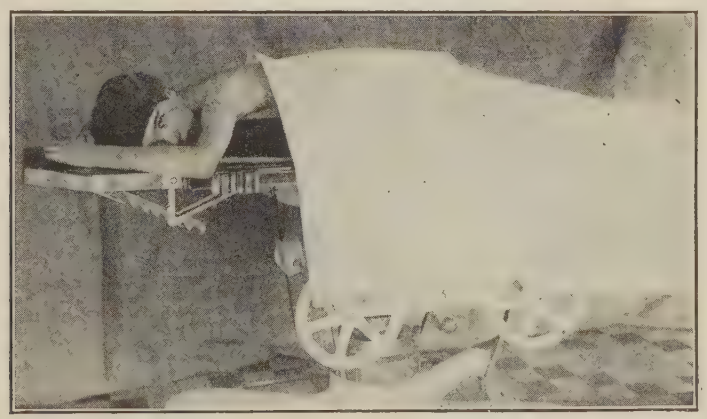


Fig. 85.—Prone Position. The patient lies flat upon his face except for one shoulder which is elevated slightly upon a small sandbag so as to turn his face away from the table sufficiently for the administration of the anesthetic. Some tables may be broken at the head so as to accomplish this purpose without the sandbag, or, the arrangement shown in Fig. 100 may be used.

anteriorly of a heavy sandbag. The crosswise rest is now screwed upward directly under the location of the kidney so as to throw the organ as well outward and upward as necessary from under the ribs. Foresight should be used in seeing that the patient is properly placed in relation to this rest before any of the preceding adjustments are made so that the raising of it will not disarrange the position. When properly arranged *the patient will incline very slightly toward his face from the true lateral position.*

This is the most *difficult position to arrange* and a great deal of practice should be devoted to it by the beginner.

The draping corresponds to that for the dorsal position.

Prone Position.—The patient lies flat upon the table with the face downward and the arms above the head (Fig. 85). Special care of the head must be taken in arranging this position. Some tables will be so constructed that a section at the head may be lowered somewhat to allow the patient's head the required room, but in place of this a small pillow or sandbag may be placed under one shoulder.

This position will be *used for operations upon the spine* or other parts of the back.

The dorsal draping may be adapted to this position.

Latero-Prone Position.—This will be *used for operations upon the chest* (Fig. 86). The body is turned about halfway

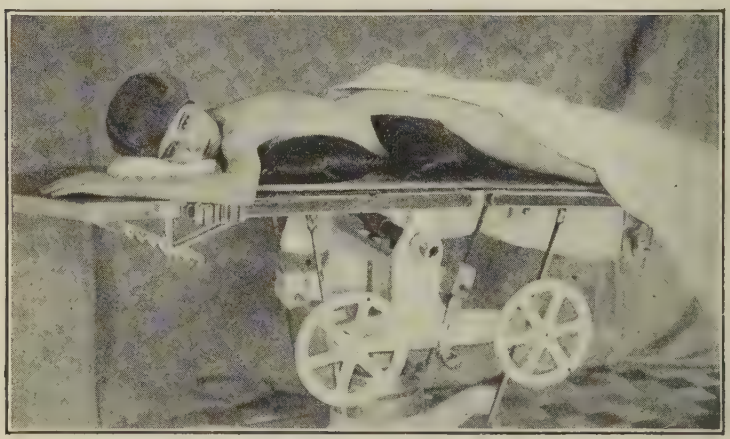


Fig. 86.—Latero-prone Position. The patient is inclined about halfway between the lateral and the prone positions, and the sandbags under the chest and the hips, and his flexed knees, stabilize him.

between the lateral and the prone positions, and the chest and hips rest against sandbags, the lower arm lying at the back and the other upward toward the face.

The dorsal draping is adaptable to this position.

Reversed Trendelenburg, or Kraske Position.—The patient is placed upon the table face downward with the hip joints directly over the line at which the foot section of the table breaks, with the arms over the head. Screw the table upward as in the Trendelenburg position, allowing the foot to drop at the same time (Fig. 87). The patient will be so well balanced

in this position, as a rule, that the shoulder guards will not be needed.

This position will be *used for some operations upon the rectum.*

The principles of *the dorsal draping* will apply here.

FIG. 87.—REVERSED TRENDELENBURG, OR KRASKE, POSITION

FIG. 88.—SIMS POSITION, SHOWING THE USE OF ONE SHEET FOR DRAPING. The patient inclines slightly forward from the lateral position, has his knees drawn upward, and if he is under an anesthetic he will need a sandbag against his hips and chest to stabilize him.

Sims Position.—This will be used occasionally for *examinations of the rectum.* There is no essential difference in the arrangement of the patient's body between this position and the latero-prone one, except that the patient will lie on the left side.

As *the draping* will rarely ever need to be sterile the way in which it is done is not important, but Fig. 88 will show how it may be done with one sheet.

Lithotomy Position.—For this position (Fig. 89) some kind of leg supports will be needed. Metal ones called stirrups (see

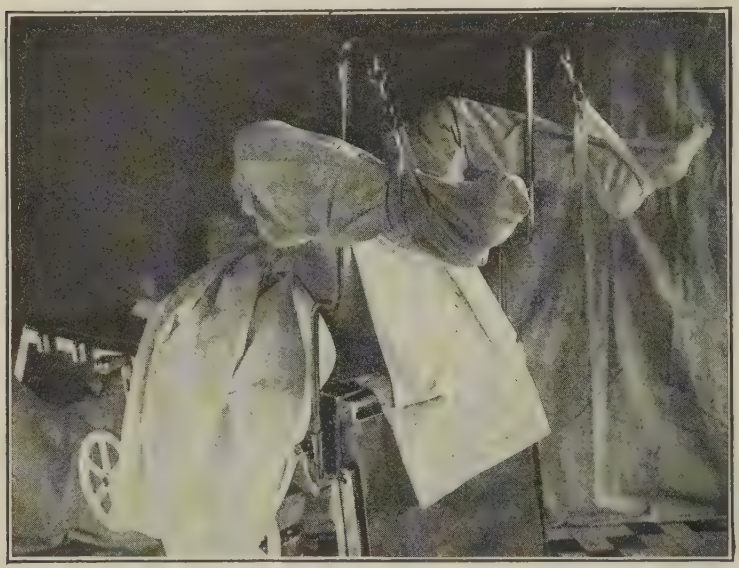


FIG. 89.—LITHOTOMY POSITION, SHOWING THE USE OF THE TABLE STIRRUPS. In most cases a Kelly pad should be used with this position.

illustration) will doubtless be supplied with your table, but if not, one of the devices which we describe in Chapter XXII, page 468, under improvised positions for operations in the home may be used. The stirrups are put into place, the foot of the table is dropped, the patient's feet being held meantime, the patient is drawn down so that the buttocks project slightly over the end of the table, and the legs are then fastened upward and backward so as to throw the knees well backward toward the abdomen. Sometimes a sandbag may be placed under the buttocks to adjust the position of the pelvic organs, or, for

the same reason, the foot of the table may be slightly elevated as in the Trendelenburg position. A Kelly pad or a rubber sheet should be used over the end of the table. In this position *the arms* will have to be arranged at the chest.

The lithotomy position will be *used for some gynecological, genito-urinary and rectal operations.*

The draping may be done with a sheet and towels (Fig. 90), or, better, with the lithotomy stockings and towel (Fig. 91) described on page 278.

Breast Position.—For operations upon the breast the patient will lie upon her back. If the disease is malignant the axillary glands will be removed as well as the breast, and in this case the arm on the affected side must be free. Usually a small pillow or sandbag will be placed under the shoulder on this side to throw the axilla well up from the table (Fig. 92). *The uninvolved arm* may be placed either at the side or on the chest.

FIG. 90.—DRAPING WITH A SHEET AND TOWELS IN THE LITHOTOMY POSITION. The blunt towel clamp will be needed to keep the sheet in place at each heel and to bind the sheet and towels together about the stirrups.

For a simple breast operation *the dorsal draping* will apply. When the axilla is involved, however, the draping is more complex and may be done as follows: After the operative field has been sterilized the patient's head and shoulders are lifted, a rubber sheet is spread under the shoulders and over the side of the table by an assistant, and a sterile sheet is then passed under the shoulders so that the table is well covered in the

region of the axilla; the hand and forearm, which have been held by an unsterile assistant, are then covered with sterile towels, beginning at the hand with one which is folded once crosswise, making a nearly square cover which is allowed to fall in folds about the wrist, and continuing from the wrist to the operative field with towels folded lengthwise, bandage fashion

FIG. 91.—DRAPING WITH THE LITHOTOMY TOWEL AND STOCKINGS FOR THE LITHOTOMY POSITION. A blunt towel clamp will be needed at either edge of the towel near the top to keep it in place. If this towel is wet it will stay in place better.

(Fig. 93). Wet towels are better for this purpose as they stay in place better. The general principles of the dorsal draping may then be applied, the arm and the axilla being, of course, a part of the operative field (Fig. 94).

There is an attachment supplied with the more complete tables which will be very useful in the breast case—*the Kocher guard,* and it is simply a semicircular piece of soft metal which

is fitted vertically across the table in about the plane of the patient's chin (see Figs. 92, 93 and 94), and serves the purpose of holding the upper sterile sheet well up between the operative field and the anesthetist. This is a very serviceable attachment, and if not supplied with the table may be very easily improvised. There are other devices designed to serve the same purpose but the Kocher guard is adaptable to a greater variety of positions as it is made of soft metal and can be bent into any desired shape (see adaptation of it for neck cases in Fig. 102,

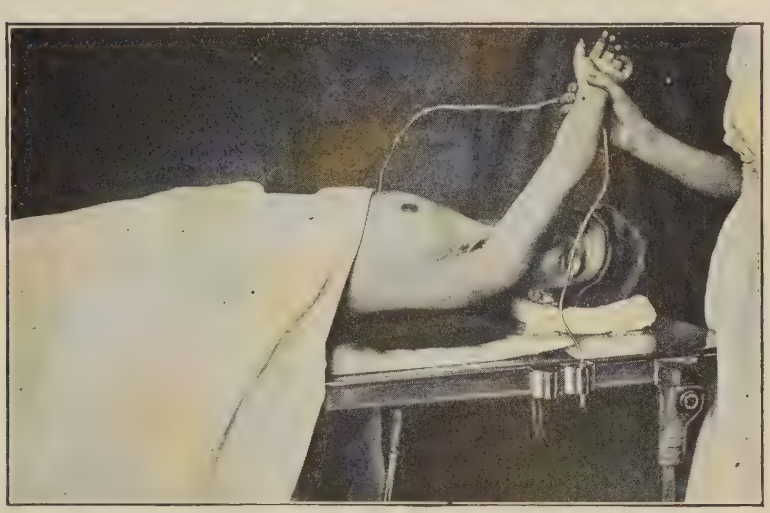


FIG. 92.—BREAST POSITION. A small sandbag will be necessary under the shoulder, if the axilla is involved, to throw the part away from the table. Note the wire arch, the Kocher guard, which extends across the table in the plane of the patient's shoulders. A draping sheet thrown across this isolates the anesthetist from the operative field. (See Fig. 94.)

page 347). In some operating rooms a guard of this kind will be used as a routine for the isolation of the anesthetist.

Arm Position.—Many hand and arm operations can be done with the part simply laid upon the patient's body, but often a small table will be needed, an arm board which is supplied with some tables may be attached (Fig. 95), or a simple long, narrow board may be used as illustrated in Fig. 96.

The laparotomy sheet will serve well in some cases for *draping*, the arm being simply slipped through the opening and unsterile parts of the arm wrapped with towels as described for the breast

FIG. 93.—METHOD OF DRAPING THE HAND AND FOREARM FOR THE BREAST OPERATION. A towel folded once croswise is thrown over the hand and is then bound about the wrist with a towel folded lengthwise into a narrow strip and applied like a bandage. The remainder of the forearm is covered in this fashion, two or more towels being needed to make the draping secure, and a towel clamp serving to bind the end. (See Fig. 94.)

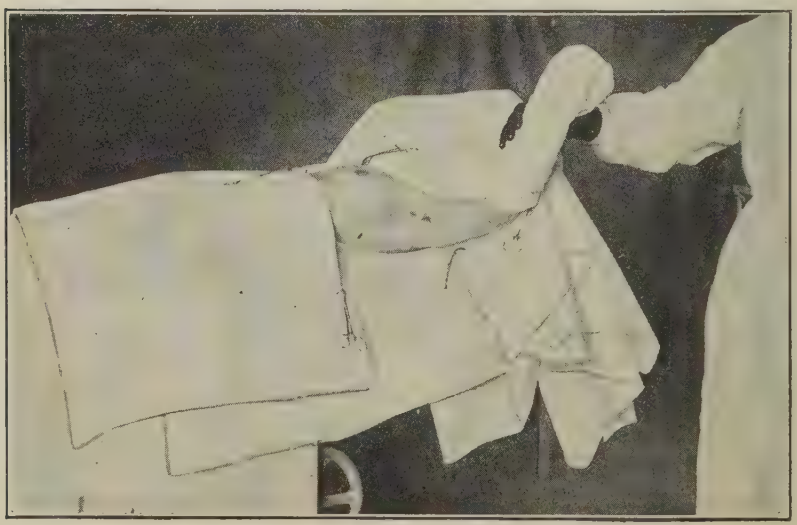


FIG. 94.—DRAPING FOR BREAST POSITION.

case (Fig. 93); or two sheets may be arranged as for the leg (see Fig. 97), any uninvolved part of the arm or hand being wrapped with towels, as just described.

Leg Positions.—A great variety of positions will be employed

Fig. 95.—Detachable Arm Board Supplied with the Table.

Fig. 96.—Simple Long, Narrow Board which May Be Fitted to any Table as an Arm Board.

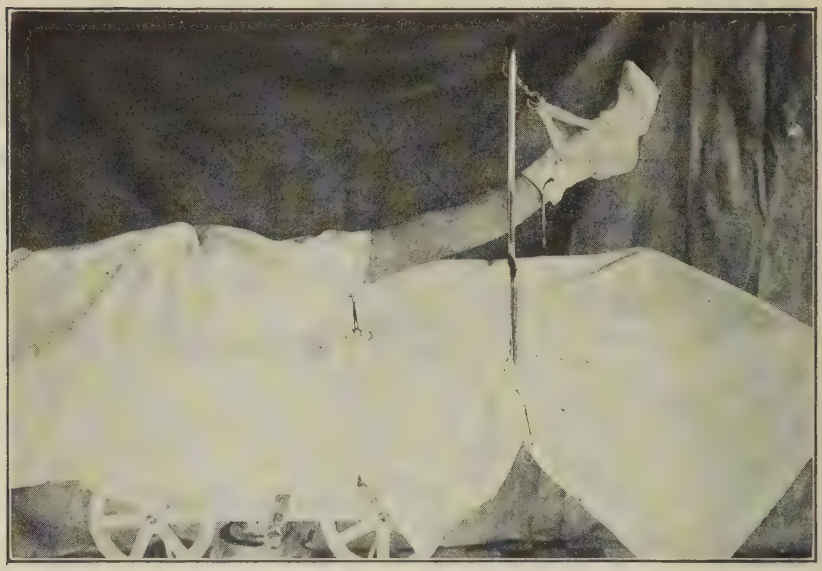


FIG. 97.—USE OF STIRRUPS FOR OPERATIONS UPON THE LEG.

from time to time for operations upon the various parts of the feet and legs, depending upon whether the anterior or the posterior aspect or both must be accessible. The simple dorsal position with a sandbag under the heel will answer for the anterior aspect of the leg and for the foot except when the heel is involved, in which case it may be necessary to turn the patient either upon his side or his face, and in this latter

FIG. 98.—DRAPING FOR LEG OPERATIONS. One sheet is used under the legs and one thrown over the patient's trunk and allowed to meet this, and the two clamped together. Considerable slack should be allowed in the lower sheet as otherwise the draping will be disarranged when the legs are moved about during the operation.

position, of course, the posterior aspects of the legs are also accessible.

Another plan which gives access to all parts of the feet and legs is to suspend them from the *table stirrups* which are used for the lithotomy position (Fig. 97). This position applies especially well in the case of operations for the removal of numerous and scattered varicose veins.

The draping for leg cases is difficult, but two large sheets and a few towels will answer all needs. The parts are, of course, first sterilized and the necessary sandbags and rubber sheets put into place, and then, while a sterile assistant holds the legs, a sterile sheet is passed underneath them over the entire foot of the table and well upward to the border of the operative field; another sheet is thrown over the patient's trunk and downward to meet the other one, and the edges of the two are then clamped together both between the legs and on the outside (Fig. 98). Extra towels may, of course, be placed upon the sheet underneath the parts if thought necessary for safety.

When the feet are not included in the operative field they must be well wrapped in towels after the fashion advised for the hand (Fig. 93); or, a very convenient plan is to use a heavy white cotton sock or stocking which can be securely clamped at the edge the same as the towel. Any uninvolved part of the leg should also be covered. When only one leg is involved the only variation will be that the other will simply be covered with the lower sheet.

When the stirrups are used they may be sterilized by boiling if a sterilizer large enough for them is available, and otherwise they may be wrapped in sterile towels.

Head Positions.—In practically all head cases a small sandbag will be needed under the head, because otherwise it will not be stable. This will simply be so adjusted as to make the operative field most accessible.

For the face and mouth (tonsils, etc.) and the front and top of the skull the patient's body will be in the dorsal position and the head turned as necessary.

For operations upon the face *the draping* will be done as follows: The patient's head and shoulders are held up and a sheet with a wet towel laid upon it is passed underneath so that the sheet will extend well up under the shoulders and the

towel will come into position directly under the head which is now laid upon the towel. This wet towel is then wrapped and clamped securely around the head and hair (Fig. 99), a sheet is thrown over the patient's body and clamped about the neck to the lower sheet.

In all operations about the head it is advisable that the anesthetist be supplied with a sterile ether mask, sterile gloves, and a sterile cover for his ether can, unless, of course, the vapor method of administering the anesthetic is used, in which case the unsterile apparatus may be carried out of the way by means of its rubber tubing.

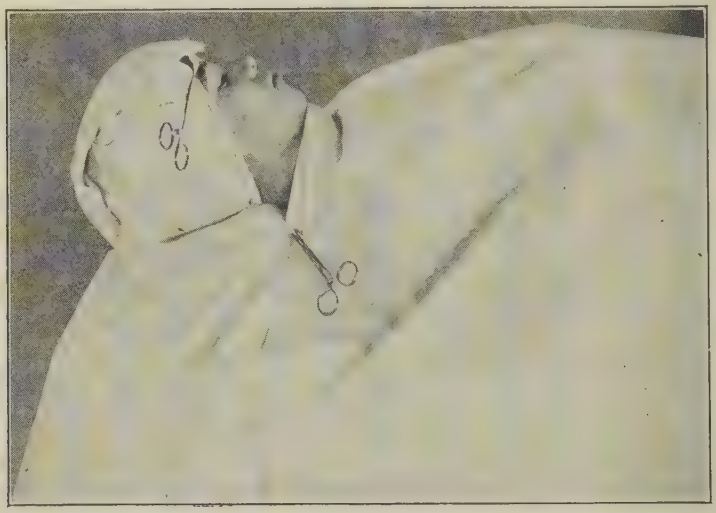


Fig. 99.—Draping for a Face Case.

For the back of the head the position just described may answer, the simple prone position may be used, or the patient may have to be placed in the prone position and some such device as is shown in Fig. 100 added for the convenience of the anesthetist. This last position, of course, involves the special equipment of the head rest, but a small table or some other article of furniture may be adapted.

For all head cases the arms should be arranged at the patient's side. This is a somewhat strained position for them when the prone position is used, but they will be too much in the way over the head.

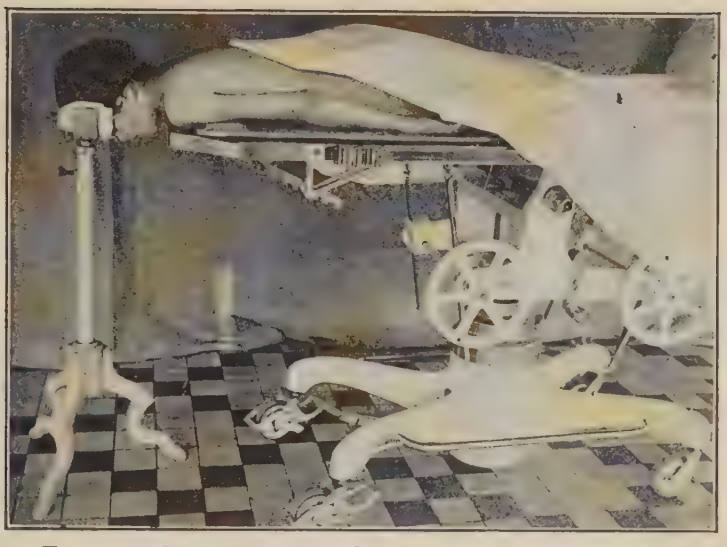


FIG. 100.—ARRANGEMENT OF PATIENT IN THE PRONE POSITION ON A SPECIAL HEAD REST FOR OPERATIONS UPON THE BACK OF THE HEAD OR NECK. Some such method is necessary when it is essential to the surgeon that the head be not turned as it would need to be were it lying upon the table.

FIG. 101.—FOLDED TOWEL CLAMPED ABOUT THE FACE TO PROTECT THE OPERATIVE FIELD FROM THE INHALER IN FACE, NECK, OR SKULL OPERATIONS.

The draping for an operation upon the skull when the patient lies upon his back or in the simple prone position will be done thus: The usual sandbag and rubber sheet are first adjusted, the patient's head is held from the table and sterilized, a sterile sheet is passed well under it, and the head may then be laid upon this, after which the top sheet is applied and a folded towel clamped about the face as shown in Fig. 101 to isolate the anesthetist. When the special head rest is used one sheet thrown over the patient and clamped about the neck and the folded towel about the face will be about all the draping necessary.

One or two metal face guards are made specially for separating the operative field and the inhaler in such cases, but draping with them will be easy if one can do it as just described.

For nose and throat operations done under local anesthesia, with the patient sitting in a chair, a towel about the head and one sheet thrown about the patient and clamped together at the back of the neck will usually suffice.

Neck Positions.—The sandbag and the rubber sheet will always be used as for the head cases, but the head will usually be thrown farther back, particularly when the operation is for goiter; and, of course, well to one side for cervical gland cases.

As in all operations about the head, the problem of isolating the anesthetist is an awkward one to solve, but where *the Kocher guard* is available it may be so bent and draped as to make a technically perfect arrangement and a reasonably convenient one for all concerned (Fig. 102). In this case, after the neck has been sterilized a sterile sheet is passed under it and the shoulders; another sheet is then thrown over the patient's body and the edge passed about the neck and clamped at the back. A third sheet is then thrown over the Kocher guard and clamped about the neck also. This latter clamp is best adjusted by an unsterile person on the anesthetist's side of the guard. There are other designs of guard which are very suitable for this purpose of isolating the anesthetist, but it is not necessary to enumerate them, for if one can adjust the Kocher guard satisfactorily the others will not be puzzling.

When a guard is not used the procedure should be in general as described for face cases, including careful isolation of the anesthetist.

FIG. 102.—THE KOCHER GUARD ADJUSTED AND DRAPED SO AS TO ISOLATE THE ANESTHETIST IN OPERATIONS UPON THE NECK.

When there is a separate anesthetizing room the preparation and draping are best done there and the table rolled into the operating room fully prepared for the surgeon. It will thus be seen that convenience will require that the sterile preparation and draping supplies be stationed in the anesthetizing room. With the drum system this will be easy, but otherwise it will be necessary to have a sterilely draped table for the purpose; or, if conditions do not make this possible or safe a small stand (Fig. 103), which is easily carried may be prepared for each individual case and carried into the preparation room each time.

Fig. 103.—Portable Dressing Stand.

THE OPERATION

What the nursing staff should do during an operation cannot be standardized in a textbook because it varies too much with the surgeon, the number of assistant surgeons, the nature of the operation, the general system of the hospital, etc.

In general, however, especially where a number of operations are done in immediate succession, there should be a recognized *head nurse* who will be responsible for the general management of the nurses' end of the work, and for the dispensation of the sterile supplies as needed. As the sterile supply drums or tables must serve for all the cases it is evident that no person but an absolutely sterile one can draw supplies from them, and this makes it obligatory that one nurse, preferably the head nurse, do nothing but *serve as the connecting link* between these supplies and those who use them. This means that she never touches anything that has been in contact with any case, because, of course, no matter how "clean" a given operation may be it is not considered clean in relation to any other, and this nurse must serve as the guardian of every patient's right to the benefit of every doubt. This may seem like overdoing the matter, and if every nurse on the staff were highly experienced perhaps it would be, but it must be remembered that the operating room,

like the wards and every other nursing department of the hospital, is a training school, that inexperience is rampant, and that, therefore, *many sacrifices must be made to the cause of education,* and many otherwise unnecessary precautions taken against the dangers of inexperience.

We have already pointed out, but it needs repetition, that *handling of sterile supplies must be kept at the absolute minimum;* and furthermore, nothing that can be handled with forceps should be touched with the gloves, for the very good reason that an instrument can be made sterile and kept so with much greater certainty than a pair of gloves on the two hands of any given, and very busy, human being.

The number of assistant sterile nurses will be determined by circumstances, but as a rule, in large institutions especially, one or two others may be present to help about the wound in the way of holding retractors, etc. An unsterile nurse to do errands will be useful; and this is logically the lesson with which a beginner should be initiated into the mysteries of the operating room in action.

One or more orderlies will be necessary about an operating room to do the heavy lifting and other heavy work which nurses cannot do. Other duties for orderlies will vary with local conditions.

Management between operations should be well thought out, and the ease and despatch with which the work of this period is done will depend almost entirely upon the number of assistants. It may not be possible for the head nurse to remain sterile at this time because it is likely that her staff will be divided between the patient just finished and the one to follow and she will, therefore, need to do some of the unsterile work between operations.

Too much haste must be avoided during the period of resterilization between operations; and special precautions must be taken, of course, after an infected case. Everything that has been used or subjected to contamination in any way must be *reboiled or discarded,* all soiled linen removed, the floor basins emptied, and the floor mopped. Where possible the patient should have been taken to another room (the recovery room), or at least a distant corner of the operating room, before blankets are applied or other preparations made for the transference of

the patient to his bed, as a great deal of dust may be raised in this process and other unsterile things scattered about. Gown, or apron, and gloves are of course changed, and before the fresh ones are put on the hands should be rinsed in the bichloride or other solution again, because it is rarely possible that one has avoided contact with the soiled gloves or gown in the act of their removal.

Attention should be called here to an item which is often overlooked, namely, that if *the operating table* has been subjected to contamination in an operation it must not be used again till it has been thoroughly cleansed. In cases of known infection it may be protected in advance by putting rubber sheets in strategic places, but contaminating drainage cannot always be foreseen, and the operating table, because of its many corners and crevices, may become through such cases a very active carrier of infection.

AFTER THE OPERATION

It will be the practice to operate upon the patients of any given group in such order that the cleanest one is done first and the least clean one last, and so, at the end of a session the operating room will be in more need of resterilization than at any time during the session. It must, therefore, have the most thorough renovation at this time.

In most hospitals the laundry will be equipped and the help trained to dispose of *the soiled linen* properly, but in any case the operating room nurse must see that no linen which is virulently contaminated is carried about until it has been rendered innocuous. Perhaps the best method of doing this is to soak the linen for several hours in a 1 per cent. or 2 per cent. solution of formalin. This disinfectant is a very active one, and it does not injure the linen.

The floor must receive special attention, especially if infectious material has been scattered about. In cases of known serious contamination of the floor it must be flushed for a time with some antiseptic solution before a maid is asked to subject her hands and knees or the mop to it. Formalin will answer well for this purpose, but it should not be forgotten that formalin, giving off its pungent fumes from a large floor surface,

will quickly make a room uninhabitable if the doors and windows have not been previously opened.

Walls and all furniture, including the operating table, which may have been subjected to blood stains or other contamination, must be well washed; and of course the dressing and anesthetizing rooms will be thoroughly renovated.

The instruments are washed in warm water and soap, hot water being avoided as it will coagulate any blood present and make it very difficult to dislodge. For the same reason clamps and other jointed instruments must be taken apart for the washing so as to insure thorough cleansing before boiling. They should then be boiled for 15 minutes. After they are boiled about all they will need to put them into good condition will be thorough drying, each one being taken apart as much as possible for this. If they are wiped directly from a hot water bath the heat which they retain will appreciably aid in completely freeing inaccessible parts from moisture and thus prevent rust. Rusted parts should be scoured gently with a fine polish, such as "bon ami," but scouring should be done sparingly for, while it may give an instrument case a brighter appearance, it materially shortens the span of life of the nickel plating. Delicately-jointed instruments should be oiled immediately, and all should be provided with a dry storage place.

Syringes and needles should be washed with warm water and soap, the interior of the needles being cleansed by forcing the soap and water through them many times with the syringe. Then, with parts separated, and with stylets in the needles, they are boiled. To dry the needles afterward, their stylets must be removed and alcohol or ether forced through them several times with the syringe to carry out the water. The stylets, thoroughly dried (sometimes they are oiled), are then inserted again for storage. Needles may have gentle scouring occasionally, but a badly rusted needle is a cruel weapon to use, even after the best of scouring, and should be thrown away as worn out. The same is true of needles with bent points, though these may sometimes be salvaged by the instrument maker. In any case, inspect needles carefully before putting them away.

The gloves are well scrubbed on both sides with soap and warm water, hot water being precluded for the same reason

as for the instruments. It is even more important that blood should be thoroughly removed from gloves as the sterilization will render absolutely irremovable any that may have been left upon them. Before further handling they should then be boiled for about 5 minutes, not being put into the water, of course, till it has reached the boiling point; and then they are dried and tested for holes. The test for defects is an important one, and a great deal of practice will be necessary to learn to do it without oversights. It must be remembered that the smallest pinhole may allow the passage of infection to the wound from the hand, and that all tests must be made with these in mind. A good method is to hold the cuff open, the fingers of the glove being downward, in which position they will be well inflated with air; then quickly grasp the edges of the cuff together, confining the air which, under a little pressure, can be felt by the cheek, for instance, escaping from the smallest perforation. If the glove is in good condition generally, the holes should be patched, as nurses and junior staff assistants can wear patched gloves without inconvenience. Too great economy must not be exercised, however, in the salvaging of torn gloves because when a glove becomes so old and lifeless that it tears easily it is a menace and should be thrown away. Cuffs and other strong parts of badly torn gloves can be utilized for patches.

Patching is something of an art, too, but if done skillfully a patch will usually outlast the remainder of the glove. It is done thus: Turn the glove wrong side out—this is important because the wrong side of the rubber is usually rougher than the right side and the cement will therefore adhere better; locate the hole accurately; cut a patch to fit; sponge both the patch and the region of the hole rather vigorously with benzine—this will cleanse the surfaces and at the same time somewhat roughen them; apply a thin coat of rubber cement to the patch, quickly put the patch into place, and press firmly for a few moments until the cement has dried well. Note that the cement is better applied to the patch than to the glove, because it will not be possible to estimate the exact space required on the glove. A light sponging with benzine over the region will complete the process neatly. Do not sterilize these gloves until the cement has had several hours in which to dry completely.

All unused sterile supplies which have been opened must be

resterilized, including all drums. This may seem like another case of overprecaution, when little has been used from a parcel, but if this were not made the rule such a parcel might remain in reserve too long; for it ought to be the practice to resterilize all supplies at least as often as once a week. For this reason it is not good technic to keep more than one week's stock sterilized ahead, and some system ought to be in operation whereby the parcel longest in reserve should always be used first. In a large establishment where it is hard to follow every detail regularly, it is wise to mark each parcel with the date of sterilization so that too old ones may be detected.

All the miscellaneous utensils used must, of course, be resterilized before they are stored away.

CONCLUDING SUGGESTIONS

Aim to have only *standard equipment,* and no more of that than you use.

Try to keep your methods and your entire *system as simple as possible.* The natural tendency of operating room technic is to become complex and involved and constant good management is required to prevent nonessentials from superseding and supplanting essentials.

Do not overstock in *sterile supplies,* and keep what you have in circulation.

If your operating room is a training ground for pupil nurses do not forget *the educational phase* of the work in the press of routine requirements. The two can prosper hand in hand but all concerned must recognize them both and someone must study the system and guide it wisely.

CHAPTER XVIII

INSTRUMENT PASSING

The subject of instrument passing is a very difficult one to present on paper because it must be treated so largely in terms of conjecture. There are hundreds of operations which may be performed upon the human body; each surgeon determines his own equipment and technic in many respects; and cases, on their own account, unceasingly present diversities and irregularities of requirements to the instrument passer which cannot possibly be foreseen. The best one can do, therefore, is to survey the field in a general way. After all, however, an instrument passer who is familiar with her equipment in general and who has established her fundamental technic will have little difficulty in making the adaptations indicated as she goes along.

EQUIPMENT

The equipment which the instrument passer is expected to have well in hand may be classified as: 1. *Instruments.* 2. *Suture Materials.* 3. *Drains.*

1. **Instruments.**—To review this subject in detail would require a tremendous amount of space because there are so many kinds of instruments and so many patterns for every purpose. The elementary way to learn about them is to *handle them* in line of duty and to *see them used* at the operating table. To this end every operating room student should serve a detail (under instruction, of course) as instrument cleaner and sorter after operations. No lesson can be more impressive as to the structure of an instrument than that of being obliged to open it, take it apart, etc., clean it, and then reassemble it. This naturally arouses a curiosity as to its use which can then be satisfied considerably by witnessing operations. A further impressive lesson can then be the assigned duty of sorting and putting away in their proper departments the day's variety of sets. Every pupil nurse can gather enough information in this

way to serve the various purposes of her general nursing, but to become a useful instrument passer one needs to have a more intimate acquaintance with the many specific types and uses of instruments. Careful examination of a good instrument catalogue is one road to this knowledge. The task will not be an exhilarating one but it will be educational as to the names and appearances of instruments. In succeeding pages will be found illustrations of many of the more generally used instruments and with them information as to their application to various operations.

2. **Suture Materials.**—Substances used for sewing wounds are of two classes: Those which are *absorbable* by the tissues, and those which are *non-absorbable* and which must (with a few exceptions) be removed as soon as the wound is nearly enough healed to hold together without them.

The *absorbable suture materials* are catgut and kangaroo tendon.

Catgut is made from the intestines of animals, usually the sheep, and consists of a strip of the submucous coat which has been twisted, rope fashion, into a fairly smooth thread, and then dried, cut into standard lengths, and sterilized. This is ordinarily called "plain catgut." It is usually absorbed by the tissues within 5 to 10 days. To make it more resistant to absorption this plain catgut is treated with chromic acid which hardens it, and then we get a suture that will hold fast as long as 20 days or more, depending upon the length of time it is subjected to the hardening action of the chromic acid. This suture is called "chromic" catgut.

The market supplies the catgut in seven sizes numbered 000, 00, 0, 1, 2, 3, 4, the No. 000 being about the weight of No. 60 sewing cotton and the No. 4 about like that of the ordinary wrapping twine used in stores. Sometimes three or four larger sizes may be obtained but they are rarely used in surgery.

Kangaroo tendon is made of the tendon from the kangaroo's tail in a manner similar to that for catgut. It is usually somewhat more resistant to absorption than chromic catgut. It is manufactured in several weights.

Catgut is by far the more frequently used of these materials, the great majority of wounds being sewed together with it, and practically all bleeding vessels tied with it.

The common *non-absorbable suture materials* are: Horsehair, linen thread, silk thread, silkworm gut, silver, aluminum-bronze, and other wires, and metal "clips."

Horsehair is simply the long hair from the horse's tail which is easily cleansed and sterilized. It is usually black in color when purchased ready for use, but when not naturally black it is dyed to make it more clearly visible against the white draping towels and the patient's skin.

Silk and linen thread are familiar to every nurse. They are usually dyed black for the reason given for horsehair. Silk is used chiefly as a suture for the skin, and linen is employed almost exclusively on the intestine and stomach. Silk is most frequently used without having been treated in any way beyond sterilization, but sometimes it is saturated with paraffin or albolene. Linen, also, is much used plain, but perhaps the favorite form is the celluloid linen which is simply linen thread impregnated with a preparation of celluloid. A common brand of this kind of linen thread is known as "Pagenstecher." The paraffin and the celluloid in these cases serve the purposes of making the suture less likely to disintegrate when used in parts from which it is never removed; and the albolene serves chiefly as a lubricant, particularly in the removal of the sutures. These threads are made in a variety of weights.

The student will recall that silk and linen were classified above as non-absorbable materials, and may wonder how these foreign bodies can sometimes be left permanently in such parts as the intestines, for instance; but it so happens that nature is capable of accommodating herself to a few such invasions by either encapsulating the invader so as to shield the more sensitive tissues from its irritating effect, by eventually disintegrating it, or by sloughing it out.

Silkworm gut is made by drawing out into a thread the ductile sac which the silkworm has just prepared from which to spin his cocoon. This is naturally white, but it is usually dyed black before it is prepared for use. Silkworm gut is a relatively strong suture material and is therefore used as a "through-and-through" suture to hold together large abdominal wounds or any wound in which there is likely to be much tension during the healing period. It is supplied in several weights.

Silver, aluminum-bronze, and other *wires* are used chiefly to suture together the fragments or ends of broken bones.

Metal clips are made of silver or some other noncorroding soft metal, and they are used for skin wounds, occasionally for ligating blood vessels, and a special "Cushing" variety is sometimes used in brain surgery. The clip which one is likely to see oftenest is the one called the "Michel" skin clip (A of Fig. 104).

In rare cases the instrument passer may prepare her own catgut but oftener she will use it from glass tubes (Fig. 67). Horsehair, also, will usually be used from the tubes. The silk and linen

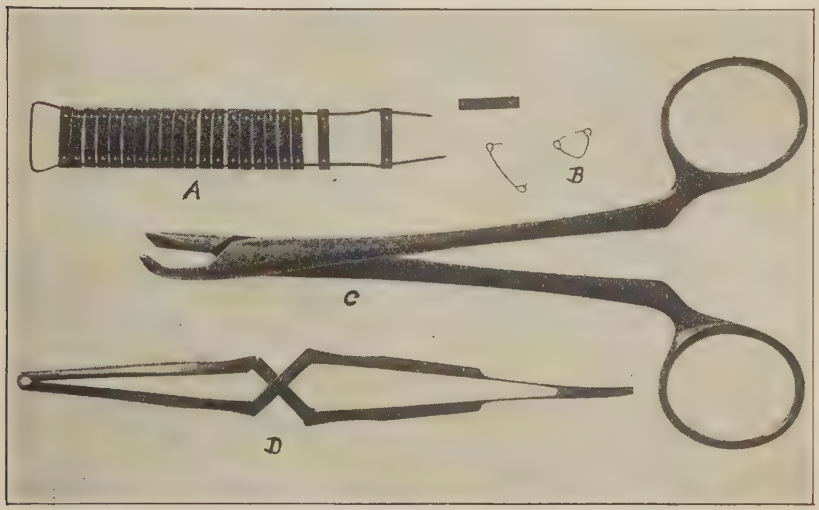


Fig. 104.—Michel Clips and Forceps. *A*, clips as packed for handling; *B*, side view of clip as it appears when applied to the wound; *C*, forceps for removing the clips; *D*, forceps for applying the clips.

threads and the silkworm gut she will probably prepare, though these are also provided in the tubes. Occasionally one may purchase these materials, especially the lighter weights, threaded on appropriate needles (see B of Fig. 67).

For preparation and sterilization of suture materials see pages 307-314.

3. **Drains.**—It will usually be the instruments passer's duty to make the wound drain. As it must be made to fit the particular case it cannot be prepared in advance of the operation. This means that one will need to make it quickly, as a rule, and for this reason she should practice the fashioning of the various

designs until she becomes dexterous and versatile at it. The more common drains are illustrated in Fig. 105, and they are made as follows:

A. *Cigarette Drain.*—For this a piece of rubber dam or gutta-percha tissue of suitable size will be used, and within it will be

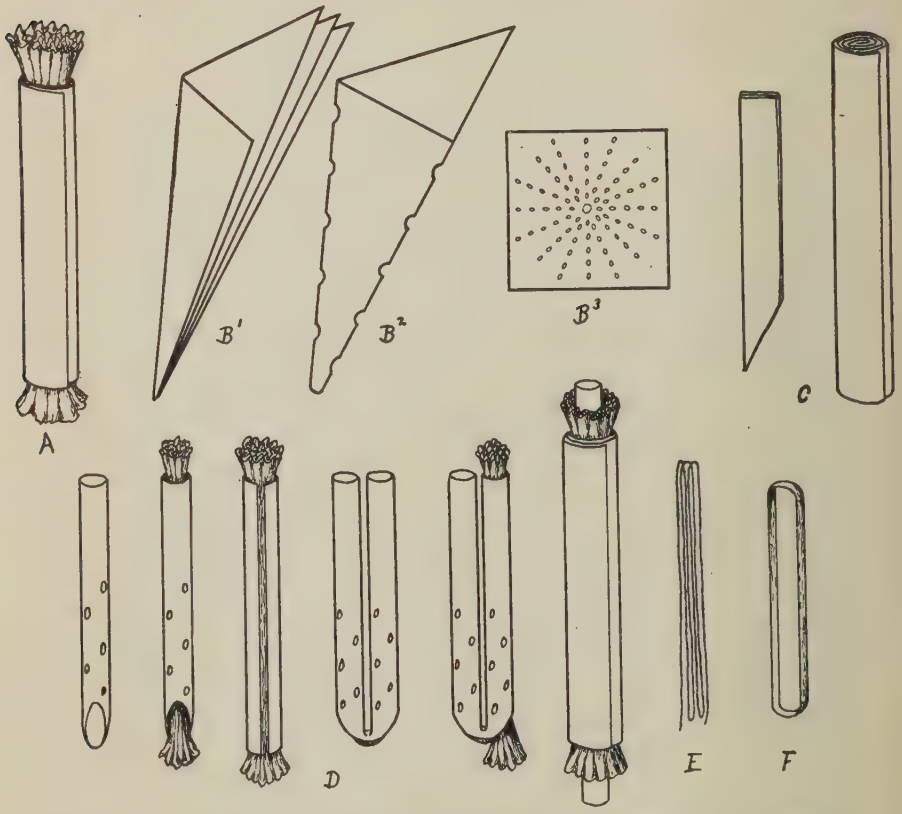


FIG. 105.—DRAINS. *A*, cigarette drain made of gauze rolled within a piece of gutta-percha tissue or rubber dam; B^1, B^2, B^3, three stages in the evolution of the Mikulicz drain which is made from a piece of gauze or rubber dam; *C*, gutta-percha tissue or rubber dam drains made by folding the piece flat or by rolling it into a tube; *D*, various designs of rubber tubing drains; *E*, horsehair or silkworm gut drain; *F*, ordinary rubber band.

rolled, lengthwise, cigarette fashion, a piece of gauze of a size to fit the wound, the ends of the gauze being allowed to project slightly beyond its wrapper.

B. *Mikulicz Drain.*—A square piece of gauze or rubber dam large enough to line the entire wound is folded as indicated in

B [1] of Fig. 105—that is, diagonally several times. With a pair of sharp, curved scissors small notches are cut in this folded piece of material as shown in B [2] of the illustration. For insertion the drain will be unfolded, and after it has been perforated

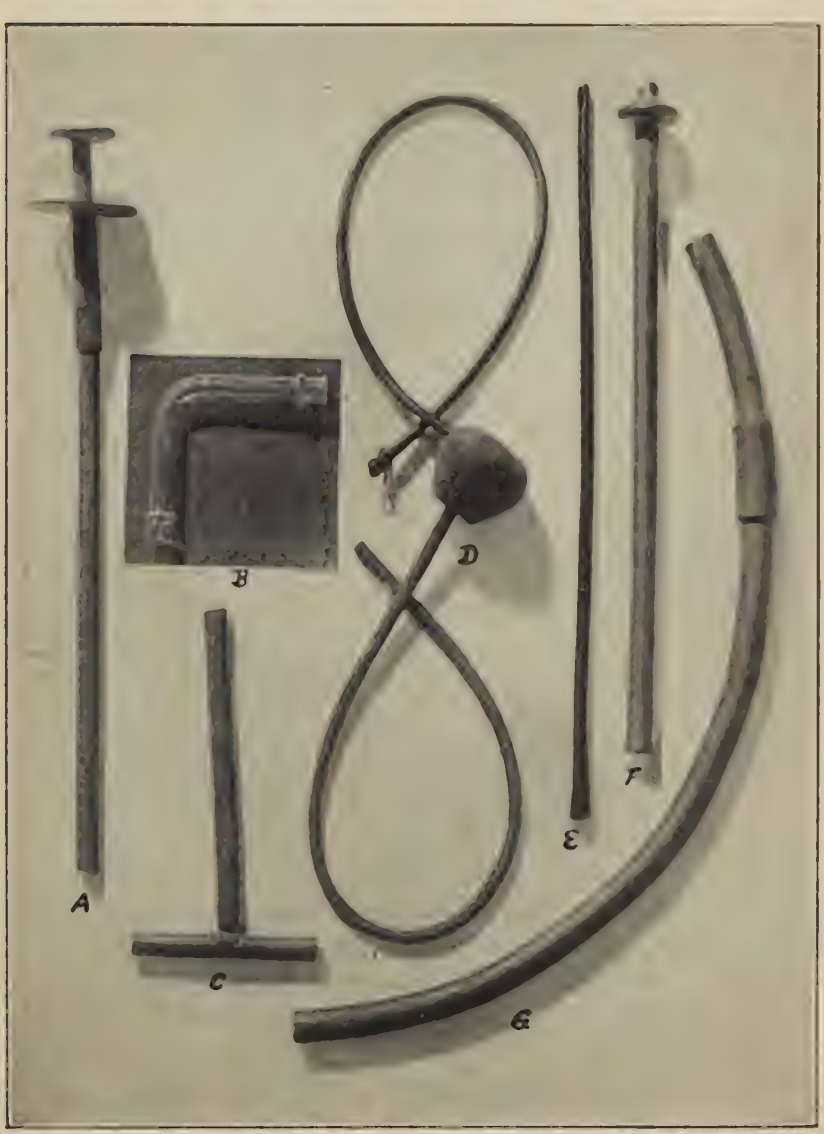


FIG. 106.—SPECIAL DRAINS, ETC. *A*, Brewer's empyema drain; *B*, Paul's tube; *C*, hepatic duct drain (Kehr); *D*, Pilcher hæmostatic bag; *E*, ordinary rubber catheter; *F*, self-retaining catheter; *G*, sleeved bladder tube.

it should appear as shown in B [3] of the illustration. When this is in place in the wound it will be packed full of gauze packing.

C. *Gutta-percha Tissue and Rubber Dam.*—Pieces of either of these materials may be folded flat or rolled into tubes of suitable size.

D. *Rubber Tubing.*—Pieces of rubber tubing may be fashioned in various ways. The gauze packing may or may not be used in these drains. The large drain of group D has the rubber tube inside of the gauze, and the whole is encased within a few layers of rubber dam.

E. *Horsehair and Silkworm Gut.*—A strand may be rolled into a suitable shape for small wounds.

F. *Rubber Bands.*—For small drains an ordinary rubber band, either whole or in part, may be used.

Several ready-made drains for special purposes are illustrated in Fig. 106.

A safety pin should accompany most of these drains either to pin them fast to the dressing or to serve as a guard against their slipping into the wound and becoming lost.

With this general equipment in mind we can now proceed to outline our system of handling it.

TECHNIC

The beginner in instrument passing should be taught the subject in easy and logically arranged stages because at best the multitude of details is very confusing at first. Plenty of time should be allowed for observation of a good technician if possible; there should be detailed demonstrations of all technical procedures; and before undertaking an actual operation the student should have practiced considerably all of the various manipulations which the work entails. For the sake of brevity let us now combine in a representative operation as many lessons as possible in the order in which they will arise in practice. *An appendicectomy* affords a greater variety of good teaching examples, perhaps, than any other operation, and the student who has learned the technicalities involved in this case will have a very firm foundation upon which to build her technic for all other cases. Let us assume then, that you are to be instrument passer for an appendicectomy.

FIG. 107.—APPENDICECTOMY AND GENERAL PURPOSE INSTRUMENTS. A, aneurism needle; *B*, blunt towel clamp; *C*, sharp towel clamp; *D*, scalpel with detachable blade; *E*, ordinary scalpel; *F*, *G*, *H*, *I*, retractors; *J*, curved blunt scissors; *K*, curved pointed scissors; *L*, plain anatomical forceps; *M*, toothed forceps; *N*, probe; *O*, grooved director; *P*, sponge forceps; *Q*, dressing forceps; *R*, large curved artery clamp; *S*, fine straight artery clamp; *T*, small curved artery clamp; *U*, fine vulsellum (Allis); *V*, *W*, two types of needle holder; *X*, heavy Kocher clamp; *Y*, crushing clamp.

The *instruments* for the ordinary case are illustrated in Fig. 107, and the numbers of each are as follows:

6 towel clamps
1 scalpel
4 pairs plain anatomical forceps (1 very fine-pointed)
2 pairs toothed anatomical forceps
3 pairs scissors (1 straight, 2 curved)
12 hæmostatic forceps
6 Kocher clamps
3 pairs blunt retractors (3 sizes)
3 pairs sponge forceps
2 small aneurism needles
1 probe
1 grooved director
2 needle holders (of the same pattern)
1 pair dressing forceps
1 "crushing" clamp. If one of the various special designs is not available a strong, straight pair of hæmostatic forceps (X of Fig. 107) may answer.

The needles will be these (see corresponding letter in Fig. 108):

2 straight "round" intestinal needles (C)
2 curved "round" intestinal needles (G)
2 curved "round" heavy needles (G)
4 curved "surgeon's" needles—2 sizes (E or F)
2 straight "skin" needles (B), except where "clips" are used.

Before going further with the preparation let us examine these needles. The term "round" as applied here means cylindrical and smooth throughout. An ordinary sewing needle is a straight round needle, and if we were to bend it like the curved surgical needles it would be a curved round needle. The "surgeon's" and the "skin" needles have sharp cutting edges (usually three) at the point. A round needle pushes aside the tissues, just as a sewing needle does the cloth, and does not cut them, while the surgeon's and skin needles cut their way through. The "intestinal" needles are merely the very fine ones of the round variety.

The suture material will be:

Plain catgut, Nos. 0, 1 and 2.
Chromic catgut, Nos. 0 and 2.
Linen thread (or celluloid linen—Pagenstecher).

Silkworm gut.

Silk thread, horsehair, or skin clips and the special forceps for applying them (Fig. 104).

Count all instruments which you take out, especially the

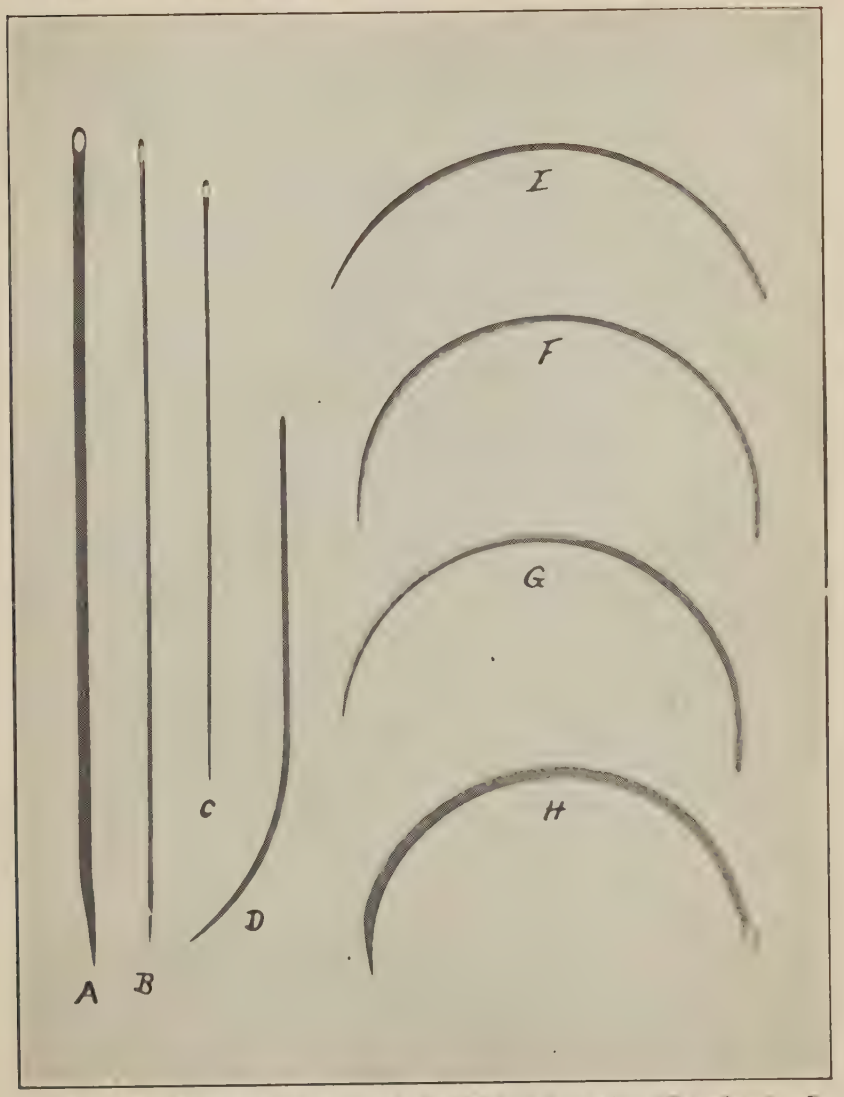


FIG. 108.—SUTURE NEEDLES. *A*, straight flat needle (Hagedorn); *B*, straight "skin" needle; *C*, straight "round" needle (intestinal); *D*, half-curved "surgeon's" needle (suitable for hand use); *E*, full-curved (⅝-circle) "surgeon's" needle; *F*, curved (½-circle) "surgeon's" needle; *G*, curved "round" needle; *H*, curved flat needle (Hagedorn).

artery clamps, so that you may account for them later if any question arises as to one being lost in the wound.

Everything being sterile and conveniently placed, you may now *arrange the instrument stand* (Fig. 43, page 244) in some such orderly way as that suggested in Fig. 109, laying aside the pair of straight scissors and one pair of the plain anatomical forceps for your own use in handling the sutures.

Next it will be wise to *make a "suture book"* from a towel

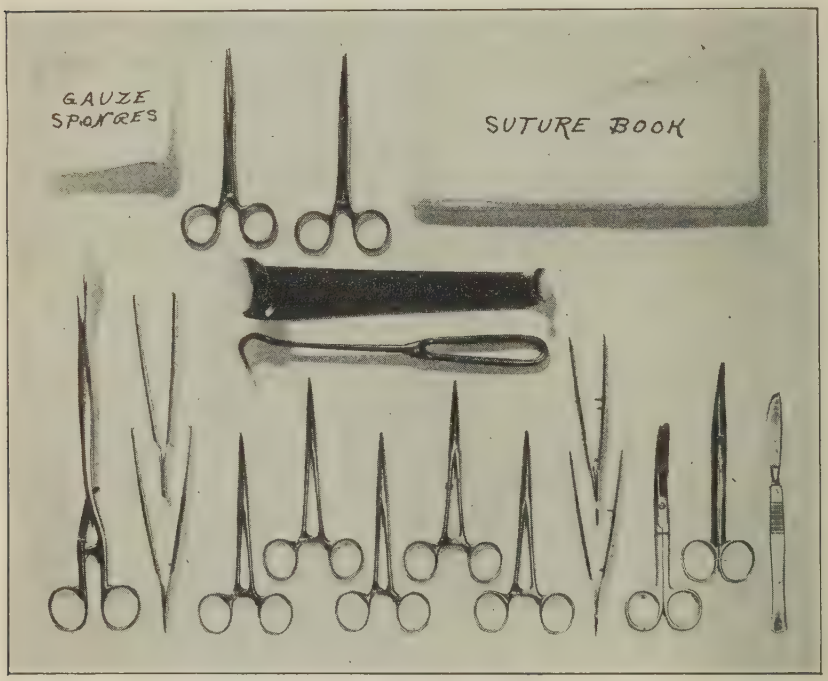


FIG. 109.—ARRANGEMENT OF THE INSTRUMENT STAND WHEN THE TYPE SHOWN IN FIG. 43, PAGE 244, IS USED.

folded as shown for the needle book in Fig. 73, page 305, namely, by these steps: (1) Lengthwise, bringing each edge to the middle; (2) crosswise, bringing each end to the middle; (3) crosswise, through the middle again, bringing the ends together; (4) crosswise, through the middle again. This will give you a compact, book-like arrangement of the towel with two compartments in which to store your sutures and needles conveniently. This is, of course, not a necessity but one of those conveniences which

will never be discarded when once tested out, for if one assigns a place to each kind of suture material a great deal of time and trouble will be saved in finding what one wants when pressed for time.

Now, *arrange in this book the suture material* and accompanying needles. These will vary with surgeons and with patients, so what we shall state should be considered as only a general guide.

The suture material will consist of *sutures and ligatures*, the suture being cut about 30 inches long and the ligature about 15 inches. Usually the strand in one of the glass tubes will measure 60 inches, thus making two sutures or four ligatures.

Before attempting *to open one of these tubes* fold a towel down to about the size of the suture book (not necessarily in the same way) and place it on an out-of-the-way corner of the instrument table. Now select a tube of No. 1 plain catgut. Crosswise of the middle of this will be found a filed groove which has been put there to weaken the tube in that place and thus make it easily breakable there. Lay the tube inside of the folded towel with the file mark away from you, and then with the towel as a shield for your hands break the tube as you would a notched stick of wood, pressing away from you with your thumbs opposite the file mark. Do not risk using gauze in place of a towel for this purpose because it does not resist the broken glass well enough and the fingers may be very seriously cut in this act of exerting great pressure upon thin glass. Take out the suture, shake the glass from the towel into a floor basin, taking great care not to scatter the pieces on any other part of the table or the instrument trays, and put the towel in its place to be used again.

This piece of No. 1 plain catgut is now doubled twice, all folds are cut, and you have four *ligatures* which you will lay smoothly in the innermost fold of the suture book with the ends protruding so that they may be easily pulled out when wanted. Four ligatures are enough to prepare in advance as a routine, and the No. 1 plain catgut will be the routine kind.

Next, break another tube of No. 1 plain catgut and cut this piece into *suture lengths* (two pieces). Thread one piece on either a surgeon's needle or a heavy curved round one and lay both in the first compartment of the suture book, catching the

needle in the towel slightly. Then prepare a No. 2 plain suture in the same way. A third suture will be either the No. 2 plain or the No. 2 chromic catgut, and a fourth one may be the No. 2 plain. The fifth may be the silk or horsehair on a straight sharp needle, and as these sutures tangle easily with the catgut they should be isolated in one end of the lower compartment of the suture book.

For an appendix case a special group of sutures is necessary —the *"purse strings"*—and there will be two of them. The first one will probably be either linen or fine chromic (No. 0) catgut, and the second will probably be either the chromic or No. 0 plain catgut. Both of the purse strings are threaded on straight intestinal needles. Store these sutures by themselves in the lower compartment of the suture book.

Occasionally silkworm gut may take the place of the fourth and fifth sutures mentioned above (the No. 2 plain catgut and the silk or horsehair) and this will be threaded on a large curved sharp needle.

The suture material and the instruments are now in convenient order, and you are ready for the operation to begin.

The first instrument used will be the knife, which you will have within easy reach, as you will also have the forceps, scissors, clamps, etc., which will be used next. You will *watch all steps of the operation* closely, replacing artery clamps, sponges, etc., on the stand as they are used, and endeavoring to *keep one step ahead* of the surgeon in your preparation.

When the appendix has been drawn up into the wound you may need to supply one or more of the small *abdominal pads* for isolating the field of operation from the abdominal cavity. Before passing a pad to the surgeon attach to its tape whatever device you may have adopted as a safeguard against its being lost in the wound (an artery clamp, if you have nothing else), and then keep an accurate account of the number of pads inserted in the wound. There have been many schemes devised for this purpose, but the following is as simple and safe as any:

Have the *system of packing the pads in groups* of a certain number (three, perhaps) with a special marker attached. For instance, pin each three to a wipe with a large safety pin. The

pin remains in the wipe, and when the pads have been used this "account rendered" for three pads is carefully laid aside in a regularly assigned safe and prominent place till the pads are taken from the wound and counted. A safety pin alone may be used but this is not as safe as the combination of pin and wipe because it is smaller and more easily lost; also, a safety pin is sometimes provided with the instruments for other purposes, such as drains, and confusion may arise. Sometimes a pad will be taken out and thrown aside during an operation while others remain in place till the end. This fact calls for another routine measure—that of immediately placing used pads in a special container till the end of the operation so that they will not be thrown away with linen or other things and thus cause confusion and delay when the time for the final checking of the number comes. A special pail or floor basin may be reserved for this purpose, or a special rack with hooks may be kept in a conspicuous place and the pads hung in a row on this as they are removed. The instrument passer who pays close attention to the operation will usually know when a pad has been accidentally or otherwise removed from the wound, but often a heavy metal ring is sewed to its tape so that its fall to the floor or against the table will be audible.

The appendix may not be packed off in a way which will require this elaborate pad technic, and your first duty after the delivery of the appendix will then be to supply the *ligatures for the mesoappendix.* The aneurism needle, or a small heavy round needle in a needle holder will be used as the carrier for these ligatures. Several of these will probably be needed and you will continue to prepare one in advance till this part of the operation is finished.

In *handing the surgeon a ligature or suture* on a holder, pass the holder first with one hand, holding the tip of the free end of the suture with the other hand, and hold it till the surgeon or his assistant takes it from you. This habit is a very important one to establish because it prevents the suture from straying out of sight and from possibly becoming contaminated.

Ordinarily only four ligatures are provided in advance, but for an appendix more may be needed. However, to avoid wasting catgut, it is better to start with the four and have one or

two more tubes ready so that you can break them quickly if necessary.

Then will come the *first purse string*—the linen or No. 0 chromic catgut on the straight and fine round needle. After this you will probably be asked for the *crushing clamp.* The appendix will then be cut away and the stump sterilized, probably with the cautery. Then *the fine-pointed pair of thumb forceps* will be used for inverting the appendix stump.

At this point the instrument nurse must learn *a special lesson in technic:* The appendix stump exposes the interior of the intestine which, of course, is not sterile, and although it has been cauterized, the crushing forceps, the inversion forceps, and the knife or scissors used for cutting it away are not considered clean, and it is the instrument passer's duty to see that these instruments are discarded. A small basin or a folded towel may be used to receive both these and the appendix and immediately handed to an unsterile attendant. This lesson should be well learned and the technic of carrying it out well planned because it will apply in most operations where a part is removed, and in others where an unclean step intervenes. If one has the slightest reason for suspecting any error of technic during this stage she should rinse her gloves thoroughly in a basin of salt solution or, better, in bichloride solution followed by the salt.

After the appendix stump has been inverted the *second purse string*—the No. 0 plain or chromic catgut on the straight round needle—will be used.

If *pads* have been put into the wound they will now be *removed* and you will be expected to account for all you have given out.

Usually a few *vessels will now be tied.* In *passing out a ligature* for this purpose one should do it thus: Draw it out of the suture book by one protruding end, grasp the other end with the other hand and present it to the surgeon thus stretched between your hands so that he may grasp it easily and securely.

Then you will provide *the wound-closing sutures* in this probable order: No. 1 plain catgut on a surgeon's or the heavy round needle in the needle holder for the peritoneum; the No. 2 plain catgut similarly for the muscle; the No. 2 plain or chromic catgut for the fascia; the No. 2 plain catgut for the fat layer, or

the silkworm gut on a large surgeon's needle for the fat layer and the skin combined; the silk or horsehair on the straight sharp needle for the skin. In place of the skin suture the Michel clips may be used. You will have known this in advance and will have sterilized the clips and the special forceps needed for them with the instruments.

In some cases, usually where there is infection, the wound will be closed by means of *"through-and-through" sutures*; that is, the entire abdominal wall will be treated as one layer and heavy sutures, such as silkworm gut, will be used on large, strong, sharp needles.

In such a case you may also need to provide *a drain* which you should be prepared to make as soon as the surgeon has determined the kind. A drain is usually passed in the dressing forceps.

All through the operation you have endeavored to see one step ahead and to *have ready in advance whatever will be needed* so as to save confusion and waiting. This you can only do by watching the operation very closely. Meantime, you have kept your instrument table clean and in order, with wipes, clamps, etc., always within easy reach of the surgeon, and unneeded instruments out of the way.

You have now passed instruments for an operation which involves many of the fundamental principles of your art. You will need all the types of instruments (except the appendix crusher) for practically every operation, with special additional ones which will be pointed out later; the arrangement of the instrument table and the general supply of suture materials are standard; and your general course of procedure will apply always.

There are so many possible surgical operations, and they are performed so variously that it would be futile to prescribe specific details here as to the instrument passer's preparation for them individually. On the anatomical basis, however, there are a few suggestions which may be made with some degree of helpfulness to the beginner. Accordingly, *in the following section we give the probable general requirements for one or more representative operations from each anatomical group.* The general set of instruments which you provided for the appendix operation will be assumed, with the understanding that you will make

appropriate variations of it as to the size, shape, number, etc., of the several types of instruments. The ligatures used in the appendix example will be assumed also, as they apply universally. The suture material, however, will probably never be any more complex and elaborate than it was in the appendix case, but examples given there may safely be used as a guide to probabilities in other cases.

REPRESENTATIVE OPERATIONS

Intestines.—For operations upon the intestines these special instruments should be provided:

2 crushing clamps (A of Fig. 110).

2 anastomosis clamps, with rubber tubing covers for blades (B of Fig. 110).

Large abdominal retractors—several sizes (G, H, I, of Fig. 111).

6 pairs of fine vulsella (L of Fig. 117).

2 extra pairs of scissors and thumb forceps.

Murphy button (D of Fig 110).

The *suture material* will usually be linen thread or the Pagenstecher, and No. 00 or 0 chromic catgut; and the needle will be the fine, straight, round intestinal one usually, though occasionally a curved one will be called for instead.

When the interior of the intestine is exposed during the operation the instrument nurse must apply *the special technic* described in the case of the removal of the appendix (page 368). As in the case of the appendix, a special towel or basin should be provided for the reception of all the instruments used during the unclean stage of the operation, and the instrument passer can then manage to avoid contaminating either her own gloves or her instrument table—the extra forceps and scissors advised above were for use at this stage so as to avoid the trouble of resterilization for the remainder of the operation.

When the *Murphy button* is used the two sections should be screwed apart and each clamped in an artery clamp for convenience in handling. Some surgeons will also expect you to plug each section with a piece of gauze packing before handing it to him. As in the case of abdominal pads, the instrument passer assumes the duty of recovering these two pieces of packing before the wound is closed. Purse strings of heavy linen or silk

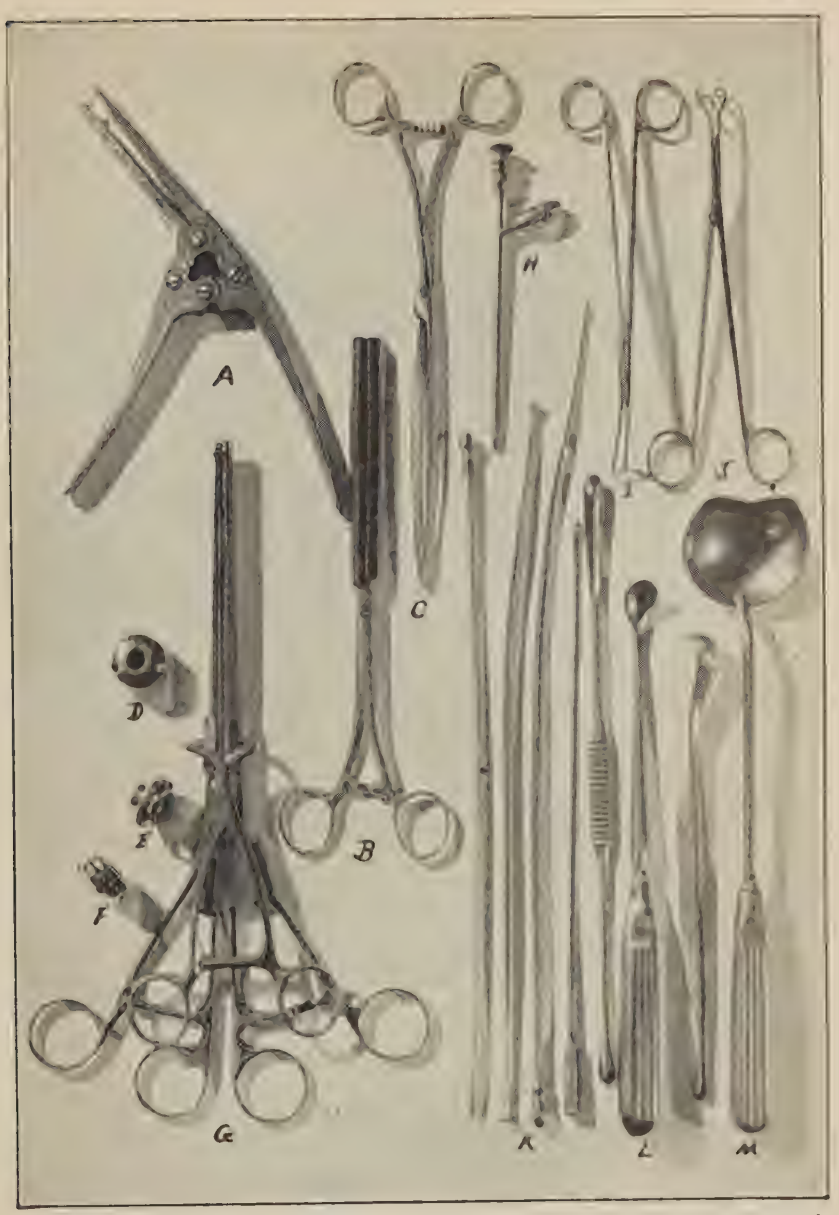


FIG. 110.—INTESTINAL, STOMACH, AND GALL BLADDER INSTRUMENTS. *A*, intestinal crushing clamp; *B*, resection clamp; *C*, same as *B*, without rubbers; *D*, Murphy button; *E*, *F*, Murphy button parts; *G*, stomach clamp; *H*, trocar, to which should be attached a rubber tube about 4 feet long; *I*, *J*, gallstone forceps; *K*, four types of bile duct probe; *L*, three types of gallstone scoop; *M*, gall bladder spoon.

thread on an intestinal needle will probably be used for fastening the Murphy button in place.

The closure of the abdominal wall will correspond to that of the appendix wound.

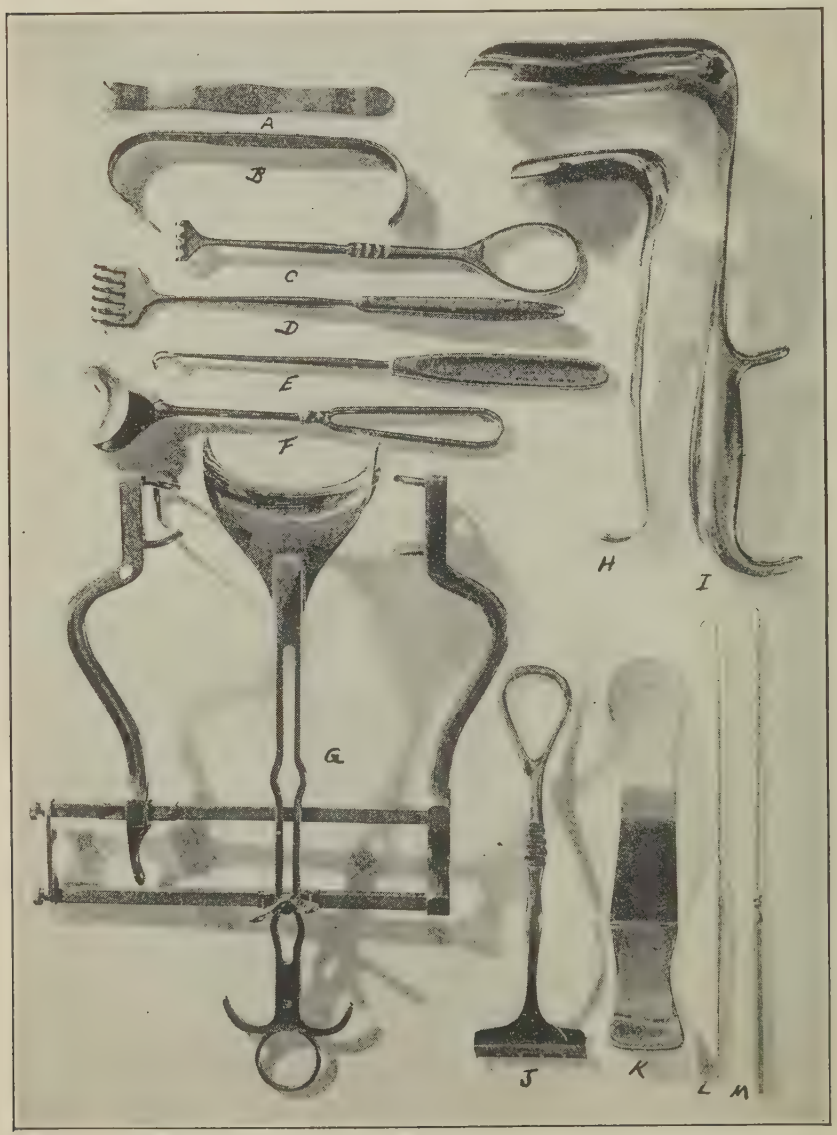


FIG. 111.—RETRACTORS. *A*, flexible spatula; *B*, small general-purpose retractor; *C*, *D*, *E*, sharp skin retractors; *F*, cheek retractor; *G*, self-retaining rectractor; *H*, *I*, deep abdominal retractors; *J*, skin grafting retractor; *K*, brain spatula; *L*, blunt tenaculum; *M*, sharp tenaculum.

Hernia.—There are no special instruments required for any of the operations for the repair of a hernia except in those cases which involve strangulation of the intestine. Then, of course, you will need to provide for an operation upon the intestines as described above.

The *sutures for hernia repair* will be in general as follows: No. 1 or 2 plain catgut on the heavier round needle for the sac; No. 2 chromic catgut, kangaroo tendon, or sometimes silkworm gut on the same needle for the muscle; the chromic or No. 2 plain catgut for the fascia; and for the fat and skin the same as for the appendix case.

Gall Bladder.—The two more common operations involving the gall bladder are the *excision* of the part and the *removal of stones* from it. The instrument passer should always provide for both, and the special instruments (Fig. 110) will be:

Gallstone forceps
Gallstone scoops
Bile duct probes
Trocar, with rubber tube
Bile spoon

If the gall bladder is removed *a strong ligature* of No. 2 plain or chromic catgut on the heavier round needle should be prepared. When it is not removed you may need to supply a medium-sized rubber *drainage tube*, an ordinary rubber catheter sometimes being used; and for closing the gall bladder around this you may need a No. 1 chromic suture on a small round needle.

There may sometimes be *an anastomosis* performed between the intestine and the gall bladder or gall duct. In this case the preparation described for intestinal operations will apply in general.

There will probably be no new feature about the closure of the wound.

Tonsils and Adenoids.—For the removal of tonsils there are many methods. Practical certainties as to instruments are a mouth gag, tongue depressor, artery clamps (long ones), and sponge forceps; and the surgeon will be the determining factor as to which of the following (see Fig. 112) will be provided:

Cheek retractors (B, F, of Fig. 111)
Uvula retractors
Seizing forceps
Enucleator, or dissector
Tonsil knife
Scissors (long ones)
Tonsil punch
Curette
Snare
Tonsillotome
Michel clips

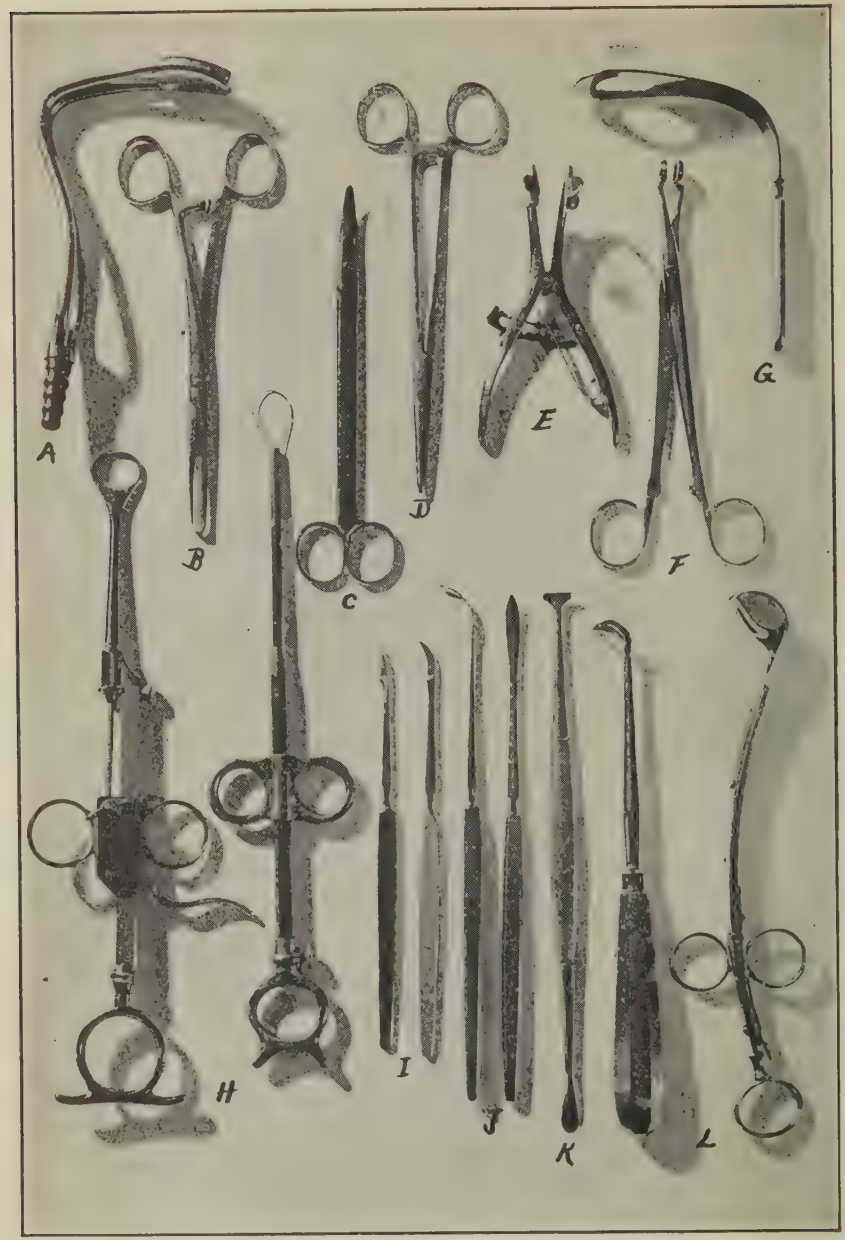


FIG. 112.—TONSIL AND ADENOID INSTRUMENTS. A, combination tongue depressor and suction tip; *B*, seizing forceps; *C*, scissors; *D*, hæmostatic forceps; *E*, mouth gag; *F*, tonsil punch; *G*, tongue depressor; *H*, two types of snare; *I*, two types of tonsil knife; *J*, two types of dissector; *K*, pillar retractor and dissector; *L*, two types of adenoid curette.

If a local anesthetic is used a syringe and needles will, of course, be necessary.

Removal of *adenoids* sometimes accompanies the tonsillectomy, and for this some kind of adenoid curette (L of Fig. 112) will be needed.

Rectum.—For *excision* of the rectum, if done *through an abdominal incision*, the preparation for intestinal work will apply. Sometimes, however, the operation may be done through an incision by way of the sacrum—the Kraske operation—which will necessitate bone instruments also. See page 380, under "Bones," for the list of bone instruments.

For *dilatation of a stricture* of the rectum there are various metal dilators, and bougies of several materials including hard rubber, soft rubber, etc. (Fig. 113).

The removal of *hemorrhoids* is usually done by the clamp and cautery method. For this the instruments needed (Fig. 113) will be:

Rectal speculum	Pile-seizing forceps
Pile clamp	The cautery

Ordinarily a rectal dilator will not be needed for a hemorrhoids operation. Sometimes a rubber tube 5 or 6 inches long, thickly wrapped with gauze and well lubricated with vaseline, will be used as a dressing.

Where a *suturing operation* is done No. 2 plain or chromic catgut on a round needle should be provided; and for a *ligation operation* strong silk may be used.

Stomach.—For operations upon the stomach, such as gastro-enterostomy or excision of part of the organ, the *intestinal preparation* and technic will apply, except that a larger and heavier crushing clamp like A of Fig. 110 will be needed, as well as larger anastomosis clamps (B, G, of Fig. 110).

Blood Vessels.—Suturing of blood vessels will not often trouble the general instrument passer. The material used is usually extremely fine silk on an extremely slender round needle. Special very fine clamps and forceps are designed for this purpose also.

For the removal of *varicose veins* one of the several designs of special vein strippers may be used (D of Fig. 113), though often nothing but the usual dissecting instruments will be needed.

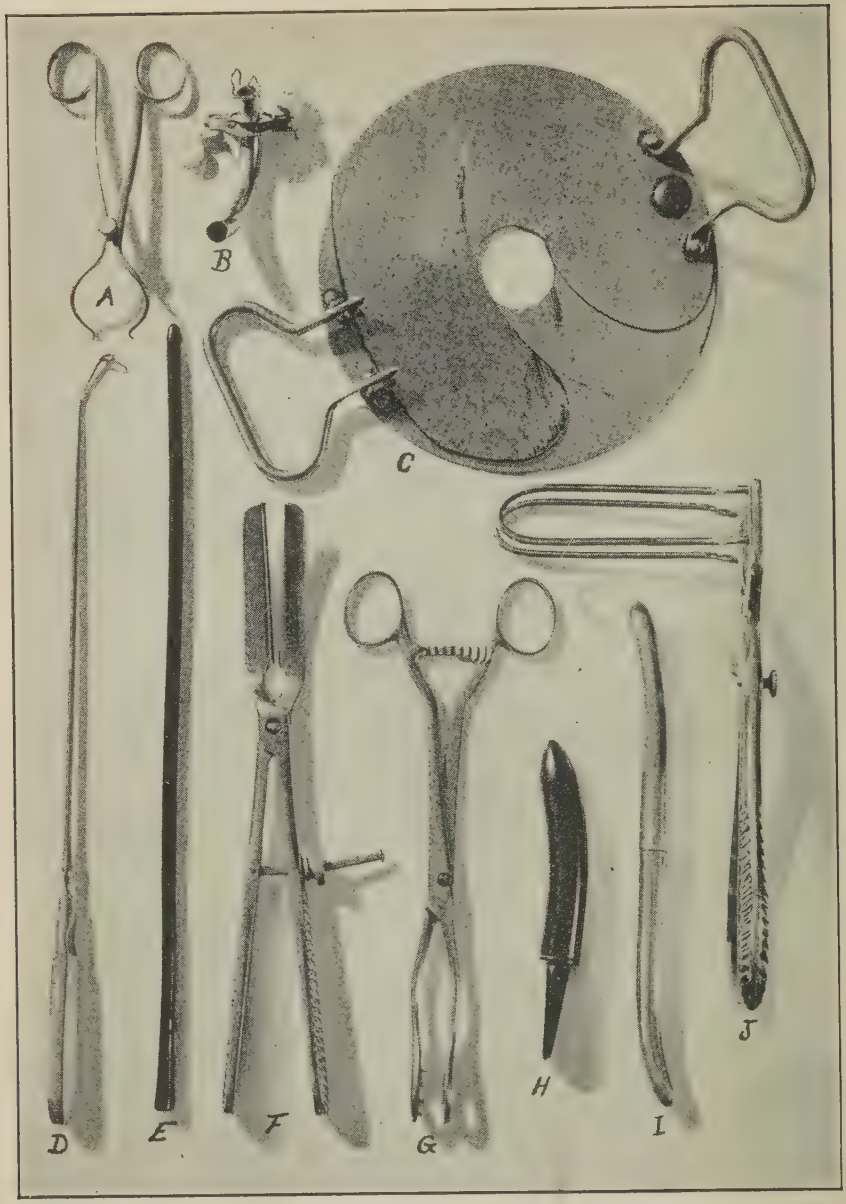


FIG. 113.—TRACHEAL, AMPUTATION, VEIN DISSECTING, AND RECTAL INSTRUMENTS.—*A*, tracheotomy spreader; *B*, tracheotomy tube; *C*, amputation retractor; *D*, vein dissector; *E*, tracheal tube; *F*, pile clamp; *G*, pile-seizing forceps; *H*, hard rubber rectal dilator; *I*, metal rectal dilator; *J*, rectal speculum.

Small sharp retractors (C, D, E, of Fig. 111) should be provided for the skin.

Lymph Glands.—About the only special instrument for these operations will be a pair of suitable grasping forceps (J, L, of Fig. 117). Plenty of artery clamps and ligatures will be a wise precaution in these cases. Plain catgut No. 1 or 2 for suturing the deeper structures, and horsehair or silk for the skin will be the likely suture material.

Spleen.—Operations upon the spleen will be infrequent. For *removal* of the organ your chief concern will be to provide plenty of large hæmostatic forceps (H of Fig. 116) and strong ligatures. Suturing of the spleen will probably be done with plain catgut on a round needle.

Thyroid Gland.—For the removal of the gland a pair of special gland forceps (H of Fig. 117) or some other suitable grasping forceps will be necessary, and there should be plenty of artery clamps and ligatures. Some surgeons will require also that there be ready a tracheotomy set with intratracheal catheters (A, B, E, of Fig. 113) for use in case of tracheal collapse. The suture material will probably be plain catgut No. 1 or 2 for the deeper structures and horsehair or silk for the skin.

Tendons.—In cases of suture of the tendon fine instruments in general will be needed with the addition of fine tenacula or hooks (L, M, of Fig. 111) for holding the tendon, a tenotome (A of Fig. 120), and perhaps a tourniquet and Esmarch bandage. The suture material will probably be fine chromic catgut or silk on a fine round needle.

Brain.—Naturally, the special instruments needed for reaching the brain will belong to the bone instrument group, and these should be provided (Figs. 114 and 115):

Periosteal elevators	Bone-cutting forceps (DeVilbiss)
Burrs and brace	Bone-gouging forceps
Trephine	Bone curettes
Chisels	Gigli saw, with introducer
Gouges	Small sharp retractors
Mallet	

For work upon the brain fine forceps and clamps in general should be provided; and thin flat retractors (A, K, of Fig. 111), a small aspirating trocar, several fine hooks, a fine aneurism needle, and a right-angled knife may be needed.

FIG. 114.—BONE INSTRUMENTS. *A*, brace and burrs; *B*, trephine; *C*, hand drill; *D*, DeVilbiss bone cutters; *E*, screw-holding forceps; *F*, Lane plates and screws; *G*, sequestrum forceps; *H*, *I*, bone-gouging forceps; *J*, rib elevator; *K*, rib shears; *L*, *M*, bone-holding forceps.

FIG. 115.—BONE INSTRUMENTS. *A*, *B*, *C*, amputating saws; *D*, Gigli saw; *E*, exsection saw; *F*, bone-cutting forceps; *G*, bone-gouging forceps; *H*, raspatory; *I*, *J*, serum curettes; *K*, fenestrated curette; *L*, gouge; *M*, chisel; *N*, osteotome; *O*, *P*, *Q*, *R*, periosteal elevators; *S*, mallet.

Very small pieces of fine gauze or cotton and fine thumb forceps should be ready for sponging, and salt solution and a syringe (A of Fig. 132) may be needed for irrigating.

Ligatures may be of very fine silk, and Cushing clips may be used.

Sutures for the dura will probably be fine catgut on a small round needle. The scalp is usually closed with either silk or silkworm gut on a sharp needle.

Nerves.—For the suture of nerves fine chromic catgut or silk should be provided on a fine round needle.

Spine.—For operations upon the spine there should be rongeurs, chisels, osteotomes, gouges, mallet, periosteal elevators, drills, perhaps an exsection saw (E of Fig. 115), small blunt hook, and sharp skin retractors. Bone wax may be used for the arrest of hemorrhage, as may also Cushing clips. For closing the wound there should be fine catgut or silk on a round needle for the dura, No. 2 plain or chromic catgut for the deep structures, and perhaps silkworm gut for the skin.

Bones.—For all bone work, such as the open repair of fractures, the removal of the whole or parts of bones, etc., general bone instruments (Figs. 114 and 115), suitable in size and shape for the part, should be provided as follows:

- Periosteal elevators
- Chisels
- Osteotomes
- Gouges
- Mallet
- Bone-gouging forceps (rongeurs)
- Bone-cutting forceps
- Bone curettes
- Bone-holding forceps
- Sequestrum forceps
- Saws
- Drills

In the case of fracture, wire may be used for suturing the bone fragments; sometimes, as in the case of the patella, chromic catgut may be needed; or, you may need to provide bone plates, such as the "Lane" plates (F of Fig. 114), and then you will also need screws, screw driver, and screw-holding forceps (E of Fig. 114). Sharp retractors should be provided for the skin.

When the *Lane plating* is done you may be expected to carry out the special *Lane technic* for the operation, which means a method by which the hands are never put into the wound, everything being done with instruments, and all supplies handled entirely with forceps. Considerable practice will be necessary

FIG. 116.—PEDICLE CLAMPS, ETC. *A, B, C, D, E, F, G, H*, pedicle forceps, *B, C*, and *D* showing only one blade of the clamp. *I*, ligature carrier, aneurism needle, or pedicle needle. *J, K*, two types of suction tip. A thick-walled rubber tube about six feet long which can be boiled should accompany these tips. *L, M*, lithotomy forceps. *N*, irrigating syringe.

before one can carry out this technic well and without great fatigue from the close application it will require. Its principle is so excellent, however, that you will do well to acquire the habit of applying it as far as you can in all your instrument and suture work, and with practice you will find that many of the things you usually fumbled with your fingers—needles, for example—can be handled much more easily and quickly with forceps.

For the closure of fracture wounds No. 2 plain catgut and silkworm gut will be the likely suture material.

Female Genital Organs.—For the various operations upon the pelvic organs through an abdominal incision there should be these special instruments:

Deep abdominal retractors (G, H, I, of Fig. 111).

2 large ligature carriers (I of Fig. 116).

Plenty of large hæmostatic forceps (H of Fig. 116).

Several vulsella or elevating forceps (A, E, F, G, I, of Fig. 117).

In the case of *hysterectomy* there will be needed ligatures of No. 3 or 4 plain catgut on the ligature carrier or on a heavy round needle in the needle holder. These ligatures should be long—the full suture length—as it will not be convenient to tie shorter ones in the depths of the pelvic cavity. After the uterus is removed the stump will be sewed with No. 3 or 4 plain catgut, and sometimes also the No. 2, on a heavy sharp needle.

Salpingectomy and *oöphorectomy* will require no further preparation.

In the case of removal of a large *ovarian cyst* there should be a large trocar with a long rubber tube attached (large one like H of Fig. 110).

For *suspension of the uterus* there are a number of possibilities in the way of sutures, but you will probably guess well if you provide plenty of No. 2 chromic catgut on a medium-sized surgeon's needle.

Occasionally some of these operations may be done *through a vaginal incision* instead of the abdominal one. This will not modify the preparation materially except that there must be vaginal retractors (C, D, I, of Fig. 118) instead of abdominal ones.

For a curettage the instruments (Fig. 118) will be as follows:

Vaginal retractor	Uterine sound
Vulsellum (I of Fig. 117)	Uterine dressing forceps
Cervical dilator	Intrauterine irrigating tip
Uterine curettes	

For *operations upon the cervix* the special instruments will be a vaginal speculum and retractor, a vulsellum, and a uterine

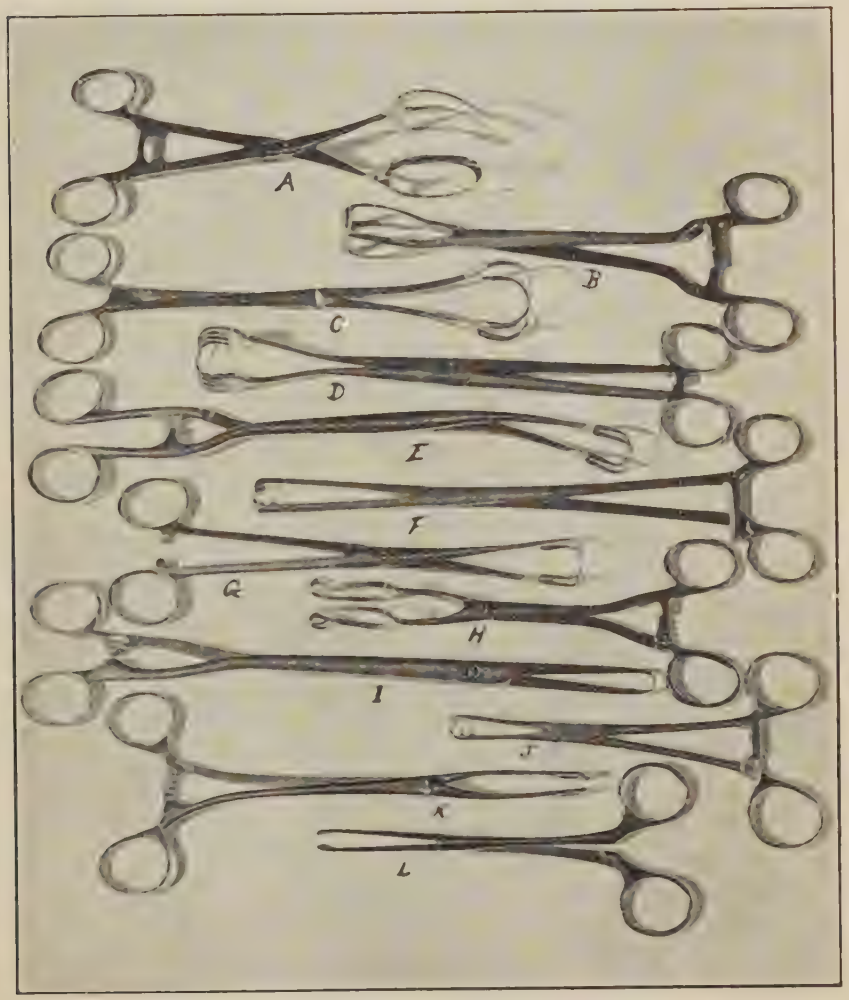


Fig. 117.—Grasping Forceps. *A*, uterine elevating forceps; *B*, prostatic forceps; *C*, *D*, tumor forceps; *E*, *F*, *G*, vulsella; *H*, gland forceps (Kocher); *I*, bullet forceps; *J*, *K*, *L*, tissue forceps. *L* is commonly known as the Allis clamp.

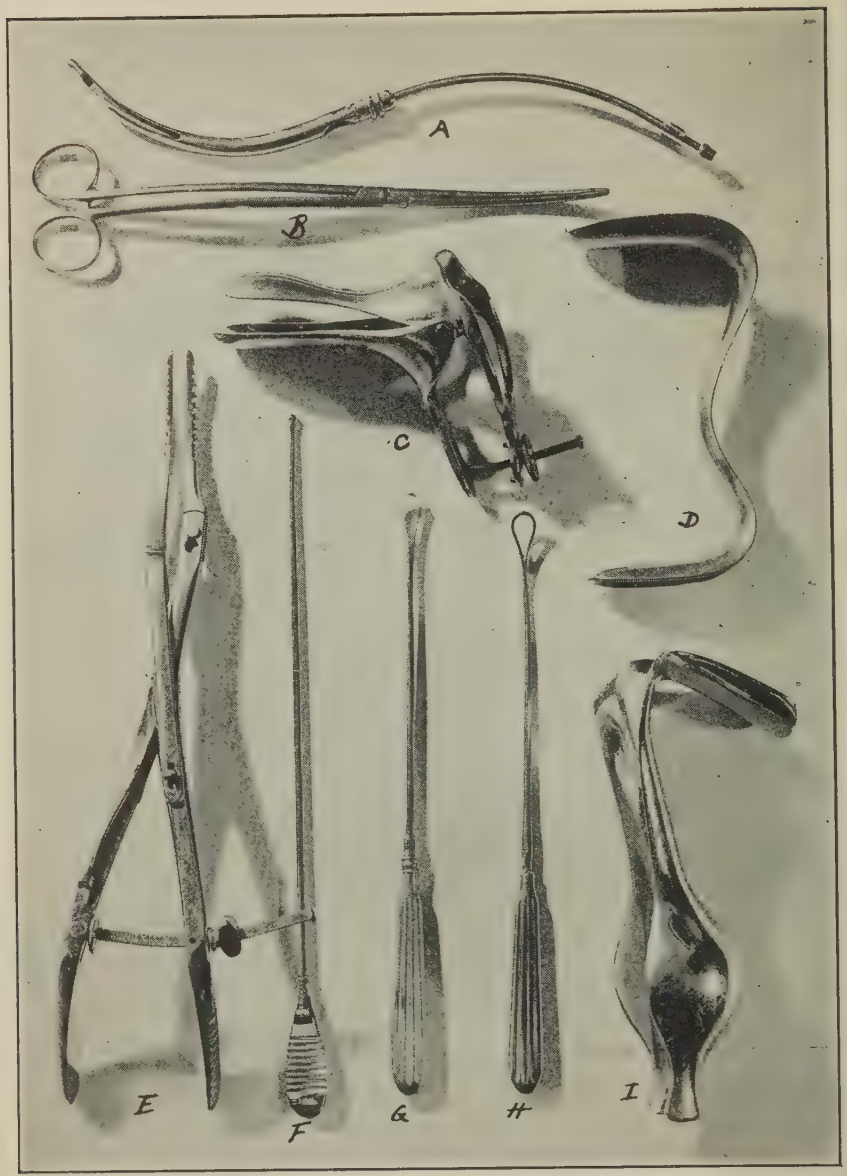


FIG. 118.—VAGINAL INSTRUMENTS. *A*, uterine irrigating tip; *B*, uterine dressing forceps; *C*, vaginal speculum; *D*, Sims retractor; *E*, cervix dilator; *F*, uterine sound; *G*, sharp uterine curette; *H*, blunt uterine curette; *I*, weighted vaginal speculum.

sound. The sutures will probably be No. 2 chromic catgut or silkworm gut on a heavy sharp needle.

For the several *plastic operations* which may be performed upon the vaginal wall several of the fine grasping forceps (L of Fig. 117) should be added to the above.

For *suturing the perineum* the probable sutures will be No. 2 plain or chromic catgut on a medium-sized round needle, and silkworm gut on a heavy surgeon's needle.

Male Genital Organs.—For a *suprapubic prostatectomy* catheters and an irrigating syringe (N of Fig. 116) may be needed for a preliminary bladder irrigation. For bladder retractors the fine vulsella (L of Fig. 117), or catgut or silk sutures with an artery clamp attached may be used. A pair of grasping forceps for the prostate (L, M, of Fig. 119), a self-retaining catheter (F of Fig. 106, page 359), and a Pilcher hæmostatic bag (D of Fig. 106) are other possibilities. Plain or iodoform packing may be used, as may also an abdominal drain which may be the kind shown in G of Fig. 106. No. 1 plain catgut for the capsule and No. 1 plain or chromic for the bladder wall will be the probable suture material. If an abdominal drain is inserted it may be stitched into place. Silkworm gut on a large sharp needle will be the likely suture material for the abdominal wall.

For a *perineal prostatectomy* these are the chief possibilities:

Prostatic tractor (I of Fig. 119).
Prostatic grasping forceps (L, M of Fig. 119).
Fine vulsella (L of Fig. 117).
Broad short retractors (F of Fig. 119).
Urethral sounds (E of Fig. 119).
Lithotomy staff (C of Fig. 119).
Gorget (H of Fig. 119).
Self-retaining catheter (F of Fig. 106, page 359).
Perineal drainage tube.
Packing, plain or iodoform.
Sutures of No. 1 or 2 plain catgut.

For *urethral operations* there will be many differences in detail as to instruments, depending upon both the surgeon and the case. See Fig. 119 for suggestive illustrations of urethrotomes, dilators, etc., and C of Fig. 120 for a urethral knife.

Breast.—For the removal of the breast the instrument passer's chief concern will be to provide plenty of artery forceps and

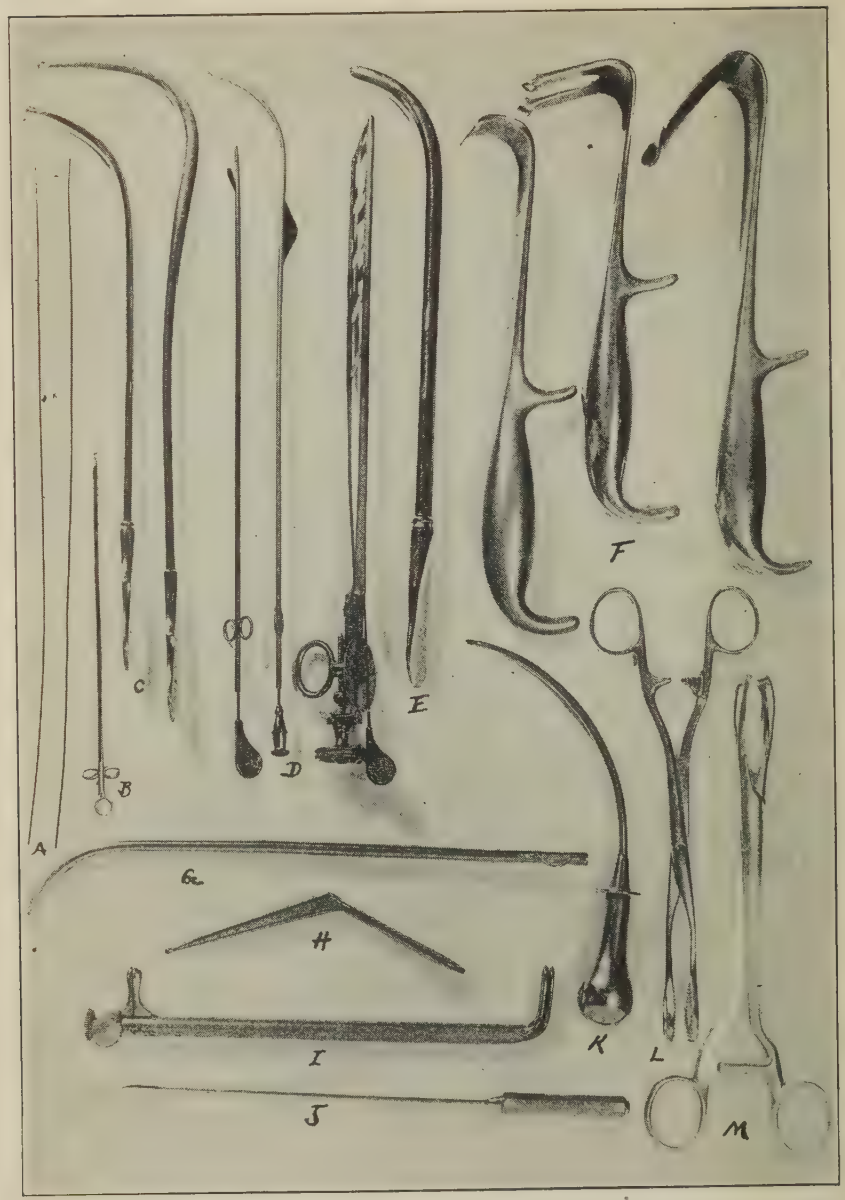


FIG. 119.—PROSTATIC AND URETHRAL INSTRUMENTS. *A*, filiform bougies; *B*, grooved director; *C*, two types of lithotomy staff; *D*, three types of urethrotome; *E*, urethral sound; *F*, three retractors suitable for perineal operations; *G*, tunneled catheter; *H*, gorget; *I*, prostatic tractor; *J*, stone searcher; *K*, trocar; *L*, *M*, prostatic grasping forceps.

FIG. 120.—KNIVES. *A*, two types of tenotome; *B*, two types of bistoury; *C*, urethral knife; *D*, skin grafting razor; *E*, *F*, two sizes of amputating knife.

ligatures. Also, a large knife (E of Fig. 120) may be needed. The sutures will usually include No. 2 plain catgut on a surgeon's needle for the deeper parts, and silkworm gut on a large surgeon's needle for the skin; and sometimes silk or horsehair will also be used for the skin.

Lungs.—The most frequent operation will be for the drainage of an *empyema*. The special preparation should be:

Aspirating syringe and needle
Periosteal elevator (ordinary)
Rib elevator (J of Fig. 114)
Bone-gouging forceps
Rib-cutting forceps (K of Fig. 114)
Drainage tube

The drainage tube may be the special empyema tube (A of Fig. 106, page 359) or it may be a plain rubber tube with several holes cut into the side of it and with a safety pin attached to keep it in place. Sometimes the wound may be partially closed with silkworm gut sutures on a strong sharp needle.

Skin.—Skin grafting operations will require the provision of a special skin grafting razor or knife (D of Fig. 120), and it must be in perfect condition. Also, special skin retractors (J of Fig. 111) may be used. There are many ways of handling the grafts after they are cut but they require no special preparation by the instrument passer except in some cases where the grafts are spread out on some such material as gutta-percha tissue for convenience in handling.

Kidney.—When the kidney is to be *excised* a few of the heavy hæmostatic forceps (H of Fig. 116) and one or two of the special pedicle clamps (A, B, C, D, E, F of Fig. 116) should be ready, as should also a large vulsellum or elevating forceps. Heavy plain or chromic ligatures on a ligature carrier or a round curved needle will probably be used for the pedicle, and smaller chromic for the ureter. The cautery may sometimes be used for separating the ureter.

When a *stone* is to be removed a pair of lithotomy forceps (I, J of Fig. 110), scoops (L of Fig. 110), and probes may be needed. The incision in the kidney will probably be closed with fine (No. 0 or 1) chromic catgut which should be threaded on a fine round needle.

For *fixation* of the kidney, chromic catgut on a curved round needle will be the probable suture material.

Ureteral catheters should be ready for use in all kidney cases.

Bladder.—First of all, the bladder will probably be irrigated,

which will require catheters and either an irrigating jar or a large syringe (N of Fig. 116). Fine vulsella, small hooks, or sutures of silk or catgut with an artery clamp attached may be used as retractors for the bladder. If there are calculi to be removed a pair of lithotomy forceps (L, M of Fig. 116) and a scoop (L of Fig. 110) should be provided. Sutures for the bladder wall will be either plain or chromic catgut (No. 1) on a small round needle. A drainage tube will usually be needed, and it may be stitched to the edge of the wound. For perineal drainage the self-retaining catheter (F of Fig. 106) may be used. Silkworm gut on a large sharp needle will probably be used for suturing the abdominal wall.

Harelip and Cleft Palate.—As these operations are usually done upon very small children all instruments should be small and fine. A simple harelip will call for no special instruments perhaps except a small curved periosteal elevator (R of Fig. 115), and several fine tenacula (M of Fig. 111) for retractors. For the cleft palate a mouth gag and tongue depressor and some such elevators as O of Fig. 115 should be added. Silkworm gut and silk are the likely sutures, and the needles should be very fine and sharp curved ones.

Amputations.—The instruments should be a saw (A, B, C of Fig. 115) suitable in size and design for the part, a knife of appropriate size (E, F of Fig. 120), periosteal elevators, bone curette, bone-cutting and bone-gouging forceps, and sharp retractors for the skin. For the arm or leg an amputation retractor, a tourniquet, and an Esmarch bandage may be necessary. A metal amputation retractor suitable for the femur is shown in C of Fig. 113, and muslin ones for the arm or leg are illustrated in Fig. 55, page 258. Ligatures, of course, will correspond in weight to the size of the stump, and those for the large arteries will usually be of chromic catgut, or sometimes of heavy silk. Sutures will probably be of plain catgut and silkworm gut.

As we have warned all the way along, what is given here is only the probable and the possible. It will now be the instrument passer's duty to learn the special methods of her surgeon and to familiarize herself as widely as possible with surgical procedures, and then she will be equipped to supplement knowledge with the good guessing which every instrument passer should know how to practice.

CHAPTER XIX

THE DRESSING OF THE WOUND

The actual dressing of the wound will either be done by the surgeon himself or the specific method for doing it will be prescribed by him if the nurse is to do the work. However, the nurse has important responsibilities in relation to all wound dressings and upon her technic and general efficiency will depend to no small degree the simplification of the treatment, the comfort of the patient during the ordeal, and the actual progress of the wound toward recovery.

Good technic is, of course, the most important thing to learn about a dressing, and the nurse's first concern should be so to arrange her supplies and equipment that asepsis will be more or less automatic.

A wound which has been sutured and has had a day or more, as most of them will have had, in which to heal somewhat, will not be as susceptible to infection as the fresh and open one in the operating room; the time of exposure for the dressing is much shorter than for the operation; and actual contact with the wound is relatively slight. The extreme precautions, therefore, of the operating room as to sterile clothing and elaborate draping are not called for in the dressing, but with these two exceptions *there should not be, and there need not be, any relaxation of rigid aseptic technic.*

The dressings which are used on the ward are essentially the same as those for the operating room (see page 261), namely, folded gauze sponges, folded gauze wound dressings, "fluffs," rolled compresses, and gauze packing of all sizes (see page 271 for suggestions about this). Iodoform packing is also considerably used.

In addition to these there should be absorbent *cotton sponges*, made by tearing (not cutting) the cotton into small circular pieces and then gathering the edges together and twisting them tightly, using a little water on the fingers; *cotton swabs*, made by

twisting a small piece of cotton onto the end of a toothpick; and a supply of *spatulas* for applying ointments, etc.—a hard-wood tongue depressor makes a good one and it saves labor because it is thrown away after use.

Also, wound *draping towels* will be necessary. Any kind of towel will do, but unbleached muslin, about 22 x 36 inches in size, does very well.

The *instruments* needed regularly will be thumb forceps, dressing forceps, probe, and scissors. Several artery clamps and a scalpel, however, should be on hand for the occasional case; and if Michel clips (Fig. 104, page 357) are used in the operating room for closing wounds the special forceps (C of Fig. 104) for removing them will be needed. With the ward infusion outfit there should be suture material (catgut, silk thread, etc.), suture needles, and a needle holder, and there will be no need of duplicating them with the dressing supplies.

Other sterilized supplies will be rubber *gloves*, an *irrigator*, a wound *syringe* (see Fig. 132, page 412), and *drainage material* such as rubber dam, gutta-percha tissue, rubber tubing, rubber bands, etc. A few *safety pins* will be needed for use on drains, and these may be boiled and kept ready in a small jar of alcohol. Sterile *adhesive plaster*, also, will be used somewhat. This may either be purchased sterilized or an alcohol lamp (and matches) may be kept ready for flaming it. There should also be a basin of hand solution, such as 1-1000 bichloride of mercury.

Unsterile supplies which pertain particularly to wound dressings include these: Adhesive plaster, bandages, large sheets of gutta-percha tissue, safety pins, rubber sheets, small kidney-shaped basins, dressing pails (or paper bags), and bandage scissors.

Drugs to be kept ready will vary from time to time and each surgeon will have a favorite for each purpose, but the following are suggestive:

Alcohol
Aromatic spirit of ammonia
Balsam of Peru
Benzine
Boric acid solution
Burow's solution (aluminum acetate)
Ether

Iodine
Ointments (boric acid, mercurial, zinc, etc.)
Powder (boric acid, zinc oxide, aristol, etc.)
Silver nitrate ("stick")
Soap (green) solution
Talcum powder
Vaseline

How one prepares and arranges these supplies for use will depend largely upon circumstances and other general equipment. If it is a case of a single dressing the best plan will be to prepare and sterilize in one parcel the proper sponges, wound dressings, draping towels, etc. This will be safest and it will also be convenient. However, in hospitals where numerous dressings must be done in immediate succession there must be a common source of supply. This can be managed by sterilizing the supplies in muslin-covered parcels and then transferring them to glass or enameled metal jars which have been sterilized separately, and which have dust-tight covers. The best technic, however, is to use the supplies directly from the container in which they were sterilized provided it can be safely opened and closed repeatedly. This will save much time and work and it eliminates the exposure incident to the transferal from one container to the other. There is a special *metal dressing box or drum* (see Fig. 121) which is ideal both as to convenience and safety. It is made with a catch which serves to prop the lid open during sterilization and to close it securely afterward. A simple mechanism on the lid serves the double purpose of a handle for carrying the box and a lever for opening and closing it easily and safely when in use. This constitutes a very compact and satisfactory container in which can be stored all of the gauze and cotton supplies, including the draping towels.

The dressing *instruments* will, of course, be boiled freshly for each dressing. The practice, sometimes seen, of boiling them in advance, drying them with a sterile towel, and wrapping them in a sterile cover for the next day's use, is one that should not be adopted except in those instances where one has not easy and prompt access to a boiler. For reasons of convenience, as well as of technic, if it is possible, the instrument boiler should be near at hand when doing dressings, especially when several are to be done in close succession. There are many portable electric instru-

ment sterilizers on the market, and if one of these can be procured and the suitable connection for it provided near the patient it makes an admirable dressing equipment (see Fig. 121). Most of these sterilizers have an attachment which automatically disconnects the current in case they boil dry, and some of them have a thermostatic mechanism which assumes entire responsibility

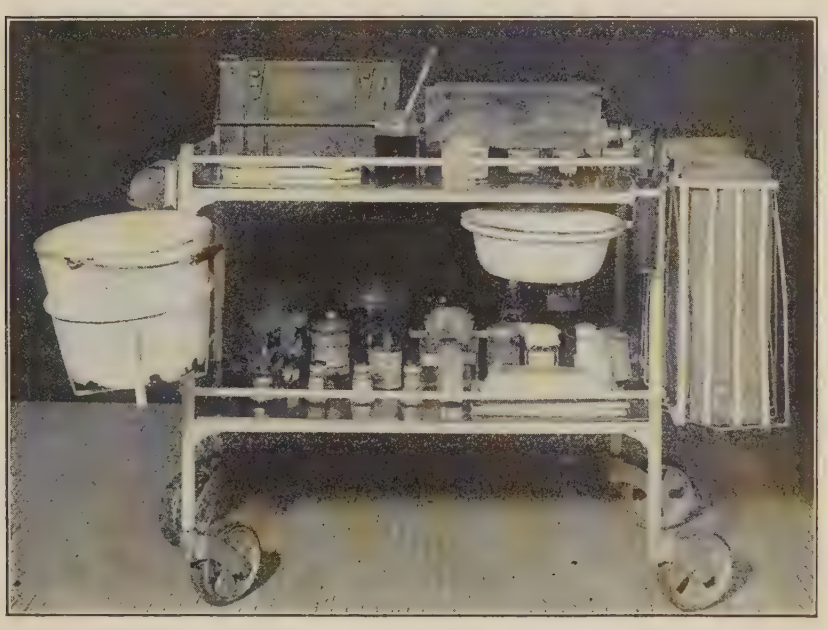


FIG. 121.—DRESSING CARRIAGE. At the left on top is the metal dressing box and at the right the electric instrument sterilizer which are mentioned on page 392. The forceps in the jar between them are the sterile dressing forceps, and those in the brass vase attached to the carriage frame at the right are the unsterile ones for handling the soiled dressings. The spools of adhesive plaster are on a roller on the left hand end of the carriage. The pail is for waste irrigating solutions, and the paper bags in the rack at the right are for the soiled dressings.

for keeping the water at the boiling point and of turning off the current if the water supply becomes exhausted.

The *gloves* may be prepared either dry or wet, the same as in the operating room. If used wet they can be boiled on the ward and stored in a basin of bichloride, lysol, etc., but the dry sterilization, of course, will be done in the steam sterilizer. For sterilization of gloves see page 299.

The *rubber drainage materials* will be kept in solution in glass jars. (For preparation of these see pages 300 and 304.)

Such things as the irrigator, wound syringe, etc., may either be kept wrapped sterilely, or they may be boiled as needed. Other miscellaneous supplies which are used occasionally may be kept sterilized in parcels or in dust-tight jars.

To have all these necessities conveniently at hand, especially when more than one dressing is to be done at a time, will call for *some means of compact and easy portability.* There is always the tray, of course, which can be very conveniently arranged and stocked, but when a variety of dressings are to be done the items it must accommodate will be so numerous and so heavy that it will be cumbersome and not very satisfactory generally. In spacious hospital wards the most convenient and technically the best device for storing and transporting supplies from one patient to another is one of the *dressing carriages* (Fig. 121) which are made in many designs and sizes. These carriages have several shelves, are mounted on rubber-tired wheels, sometimes have an attachment for elevating an irrigator, and are very simple to wheel about from bed to bed. If one has the electric instrument sterilizer and accessible wall outlets for its attachment it may be kept on this carriage also and will thus furnish an ideal means of keeping the instruments perfectly clean and ready for instant use. If wisely stocked with supplies and kept in good order this dressing carriage will save many precious steps and will enable one nurse to do all the assisting for a series of dressings without the expenditure of the valuable time of a second errand nurse.

When a patient is to be dressed the first thing to do is to *make him as comfortable as possible.* The bedding should be turned neatly back on all sides of the wound, with no more exposure than is necessary, extra blankets being used in cold weather to take the place of the regular covers on such parts as the chest, feet, etc., when possible. If you make your patient feel comfortable before you begin his dressing you have already made great headway with it for both him and yourself.

The exposure of the wound will usually involve *the removal of adhesive plaster.* Patients in good condition, and especially those in good spirits, will not mind the direct method of pulling it off, but nervous and sensitive patients, very ill ones, and especially children, will often be very much disturbed unless we adopt some of the gentler methods. Any oil—albolene or olive

oil, for examples—will soften the plaster in a few minutes, and benzine will dissolve it in a few seconds. However, if iodine has been used as the skin sterilizer in the operating room the skin may be tender, and even chafed, under the adhesive and the benzine may therefore be painful. The oils will have no unpleasant effect, even upon a broken skin, and despite the fact that they require more time the considerate nurse will use one of these more humane methods of removing large areas of adhesive plaster when the patient's feelings in the matter indicate it.

In cases where the skin shows a tendency to become sore, or is already so; where a patient is particularly disturbed by the removal of adhesive; or where the dressing needs to be changed frequently, some such method as that illustrated in Fig. 122 may be used for keeping the dressing in place. This consists merely of pairs of adhesive straps, one on either side of the dressing, connected by tapes which are tied across the dressing. These straps will remain in place for a long time and will answer all the purposes of a continuous adhesive strap, except that of great tension.

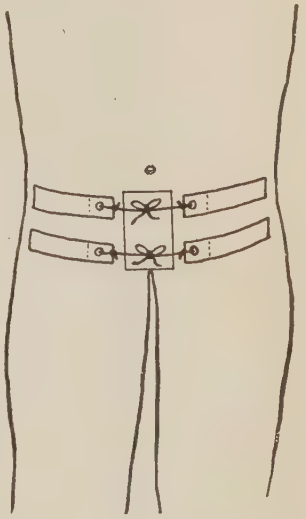


FIG. 122.—ADHESIVE PLASTER AND TAPE DEVICE FOR HOLDING DRESSINGS IN PLACE AND ALLOWING THEIR REMOVAL WITHOUT THE DISTURBANCE OF THE PLASTER. The end of the adhesive strip to which the tape is attached has been turned under for a short distance, which makes this part stronger and also prevents it from adhering to the skin, thus permitting of its being turned back out of the way while the wound is being dressed.

After the dressing has been removed a *sterile dressing towel is placed immediately above, and another below the wound.* Great care should be used to handle these towels by only one edge or two corners so that the instruments, dressings, etc., may be safely placed upon them if that is found convenient.

The general principles of handling sterile supplies for dressings will have been taught the nurse in her practical course of instruction and if she has had her operating room training she will

know them well, but *the important principle of arranging equipment and general technic so as to reduce the amount of handling* necessary cannot be urged too often. This point is not only important in the interest of asepsis, but it also saves much time,

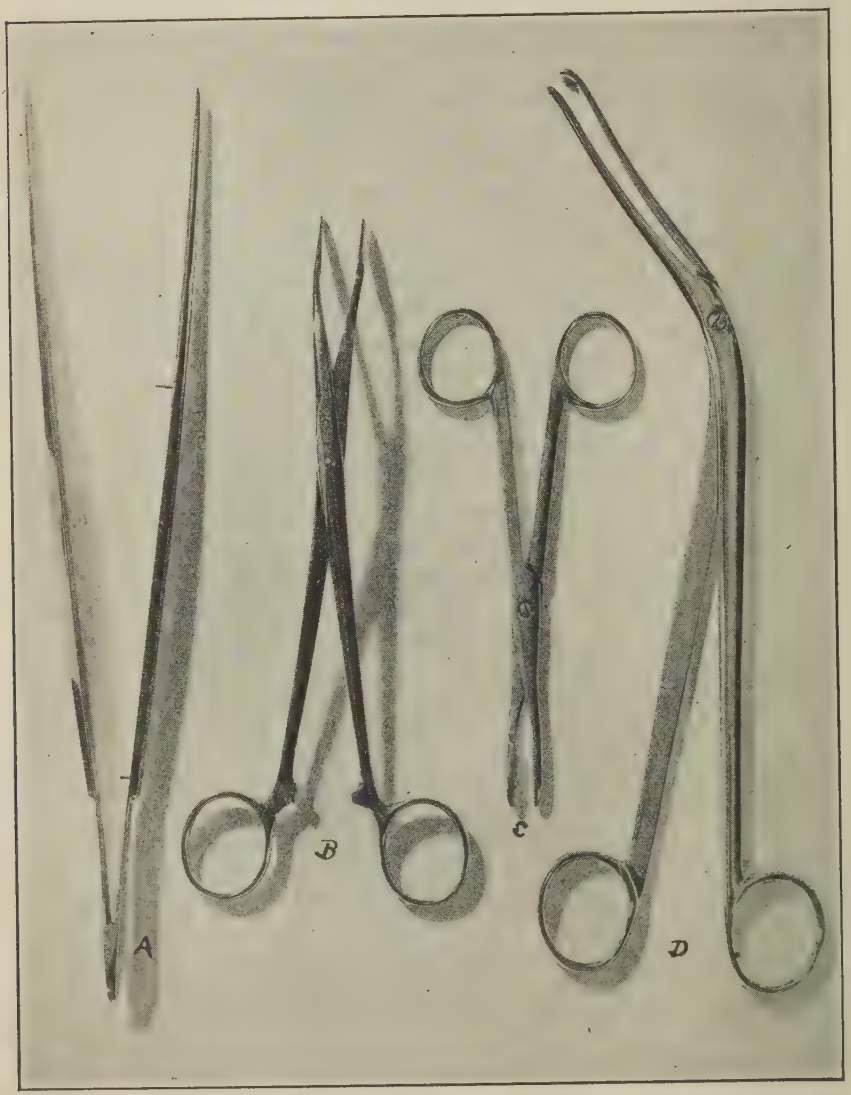


FIG. 123.—DRESSING FORCEPS. *A*, heavy anatomical forceps, suitable for the dressing tray or carriage; *B*, long curved dressing forceps; *C*, short straight dressing forceps for us in dressing the wound—especially suitable when the dressing is done with a pair of forceps in each hand; *D*, strong and well-shaped forceps for dispensing both instruments and dressings.

labor and confusion. A good standard practice is to keep a pair of long sterile forceps (Fig. 123) and a pair of scissors for use in handling the sterile supplies in a tall jar containing a solution of 1-40 or 1-60 carbolic acid to which a few grains of borax have been added for the purpose of preventing rust. These can be kept on the dressing tray or carriage at all times, and as long as they are used for nothing but the perfectly sterile dressings they need not be reboiled oftener than once a day. The point that these forceps and scissors should be long ones is emphasized because their length will enable the nurse to keep her unsterile hand well out of the region of the opening of the sterile container and thus avoid the possibility of unsterile dust dropping from it onto the sterile supplies.

In this connection it should be urged upon the nurse who dispenses the sterile supplies to *keep her hands as free from contamination as possible.* It will not be necessary for her to sterilize them but she should avoid, as far as she can, the removal of dressings, and the application of adhesive plaster, bandages, etc., after the dressing is done, especially in an infected case, if she is obliged to go directly to another wound. If an assistant is available this part of the dressing should be left entirely to her. In any case the soiled dressings should always be removed and otherwise handled with forceps. These forceps need not be sterile but it will be just as well to keep them in a jar of the weak carbolic solution on the dressing tray or carriage. The precaution should be taken to use for this purpose a different kind of forceps and jar from those provided for the sterile work, and it should be kept as far away as possible from the sterile one so as to check the user from the wrong one in a moment of lapse of attention.

In the case of wound dressing, as in that of all other ward work, it may not be amiss to caution the nurse about her technic as it pertains to the ubiquitous *bandage scissors.* The usual abiding place of these indispensable instruments, when they are not in use, is the nurse's apron belt or pocket, and it becomes automatic for her always to put them back there after use. In the ordinary everyday work this is a perfectly legitimate practice, but in the case of cutting off infected dressings the nurse should remember that her bandage scissors and her apron belt or pocket are entitled to the same technical attention as her hands

or anything else she uses, and she will, therefore, sterilize her bandage scissors whenever she has been obliged to contaminate them.

Still another reminder to the nurse dispensing dressing materials is that of *cleansing the mouth of a solution bottle* before pouring the solution over it. Iodine is expected to sterilize as it goes, but most other solutions may carry with them infected dust. It is not practicable to sterilize the mouth of a solution bottle every time before it is used, but a good technician swabs it with alcohol or some other solution which will at least wipe away dust.

Another point which is often overlooked is that solutions used for washing or irrigating wounds should not be thrown into the receptacle containing the gauze dressings. These two things are eventually disposed of by entirely different means, the dressings by way of the furnace and the solutions by way of the sewer. Thus, if thrown together they must be separated later, which entails avoidable labor and very bad technic in that much wider contamination than is necessary is caused by this solution. *Two waste dressing receptacles* are necessary if solutions are used for dressings. Whenever possible large and heavy *paper bags* should be used for the dry dressings. These can be securely closed and disposed of without the necessity of further contact with the dressings, and they save the labor of cleansing a pail (see Fig. 121).

As remarked in the beginning of this chapter, if the nurse dresses the wound herself she will have the guidance of the surgeon as to specific treatment, but she will need to exercise her best knowledge of asepsis and general surgical technic on her own account.

The person who does a dressing must have sterile hands. The bare hands may be sterilized as directed in Chapter XVII, page 318, or if sterile rubber gloves are available they should be used instead. If gloves are used it will not be necessary to put the hands through the rigid sterilizing process required in the operating room but, of course, they should be very thoroughly cleansed.

All *sponging of the wound, the handling of drains, dressings, etc., should be done with forceps* (C of Fig. 123), and to do this it will be necessary to use two pairs of forceps—one for each hand. With a little practice one can thus keep her gloves

entirely clean throughout a dressing, and can do a number of dressings without changing gloves. "Clean" dressings are always done before infected ones, of course, but as a safeguard against unconscious error the *gloves should be given a thorough rinsing after each case in some antiseptic solution,* such as 1-1000 bichloride.

As soon as possible after the dressing the patient and his bed should be restored to the usual condition. A little discomfort saved here, and a little there, hastens the recovery of health and happiness more than strong and well people are wont to remember.

The dressings done, *all exposed supplies will be resterilized.* However safe one's containers may be, and however good one's technic, it must be remembered that no container which is opened and closed frequently can be considered sterile indefinitely. The plan advised for the operating room dressing supplies in Chapter XVII, page 352, will apply here also, especially when inexperienced nurses are concerned; that is, do not hold over from one session to another a used dressing box, even though you are reasonably certain of its sterility.

Good technic is as easy to practice as bad technic, after it has become a habit. Be as good a technician as you can in your ward dressings.

CHAPTER XX

THE CARREL-DAKIN TREATMENT

The Carrel-Dakin treatment may be defined as *a method of sterilizing and healing an infected wound.* It was introduced in the beginning of the World War by Dr. Alexis Carrel, the distinguished American biologist, at his French Army hospital which was founded by the Rockefeller Institute at Compiègne, France. Dr. Dakin, who had previously introduced the solution which bears his name, collaborated with Dr. Carrel in adapting it to the particular needs of the Carrel-Dakin system.

This is a unique system made up of four interdependent processes, and it is important, therefore, for the student to learn at once that *it embraces more than the mere application of an antiseptic to a wound.* The antiseptic, the Dakin solution, is an exceedingly important factor in the case, but for the remarkable success of which it is capable it must have the coöperation of three other procedures. These four processes are taken up in practical detail, beginning on page 402, but we shall first try to learn the important and distinguishing principles which underlie the system as a whole.

You have become very familiar with many antiseptics and have sterilized many different kinds of material with the several ones, and at first thought you may not see why bichloride, for example, might not simply be applied to a wound, as you apply it to your hands, and thus kill its germs. The tissues of a wound, however, give us a very different proposition from that of the healthy surface of your hands.

In the first place, you always wash your hands very thoroughly with soap and water to remove everything but the healthy, clean surface of them before you expect bichloride to serve you; and since soap and water constitute a very good disinfectant on their own account, you have thus greatly reduced the task for the bichloride.

Secondly, the tissues of a wound are a literal culture medium

for the germs, and this means that there is present in the wound, besides the germs themselves, the dead tissue which they have destroyed in the process of their feeding upon it, and all the other waste which accompanies inflammation and infection.

Furthermore, a great deal of this material is not on the surface of the wound but permeates its walls to a greater or lesser depth. Thus, even though we were able, as we sometimes are, to wash the wounds as we do our hands, we could not reach the "soiled" parts that are within the tissues themselves, and could not, therefore, expect our bichloride to accomplish much in these parts.

More than this, bichloride, as is true of all the other powerful antiseptics which you have used, is very irritating to the tissues and while it was destroying the germs it would also destroy, or at least devitalize, the good tissue which it reached. You have doubtless learned this in the case of your own hands which have become sore or have developed a rash when you have had to use it frequently. Bichloride has been used only as an example and you would find that carbolic acid, formalin, or any other known antiseptic that is at all powerful would act similarly. Also, your hands have been only an example with which can be compared all the various articles which you are in the habit of sterilizing with an antiseptic solution.

Another more complex and abstruse problem which enters into this subject is that of actually *getting a solution of any kind into the tissues themselves*, even "clean" ones. Those of you who have studied physics and chemistry will know from what you have learned about "osmotic pressure" that there is a great difference among the powers of solutions to permeate any given material. This may be demonstrated by taking a jar with a partition of some permeable membrane, parchment paper, for instance, through the middle of it, and pouring into one side a colored solution of salt in water and into the other side plain water, and then watching them mix. Each solution permeates through the membrane into the other compartment, and in this case the water permeates more rapidly than the colored salt solution because the water is the less dense solution, or, as we say, has less "osmotic pressure." If we put the same solution into the two compartments they will mix equally because, of course, their "osmotic pressures" are equal. Similarly, if we put two different solutions having the same density into the

two compartments they, too, would mix equally because they had the same "osmotic pressure." In the study of physiology the blood serum is taken as the standard fluid for all comparisons of this kind and any fluid which has the same "osmotic pressure" as the blood serum is said to be *"isotonic"* with the blood. This term "isotonic" is one which nurses often hear and they should know its meaning, especially if they wish to understand one of the great hidden secrets of the efficacy of the Dakin solution, for it is isotonic with the blood serum and can, therefore, do what bichloride, carbolic acid, formalin, etc., cannot do, namely, sterilize a wound, because it can mix well with the blood serum through the permeable "membrane" which we have in the case of wounds—the body tissues.

Thus, in order to sterilize an infected wound we have to devise some means, first, of *"washing"* it as best we can; second, of *applying to it a solution* which has the power of killing its germs whether they are on its surface or more or less entrenched within its tissues. This Drs. Carrel and Dakin have done for us in great detail in the Carrel-Dakin system of wound disinfection; and in addition they have worked out a third measure which is an accurate system of determining, by means of *cultures*, the course their disinfecting measures are taking; and by this they are able to judge when to employ their fourth and last measure, namely, that of *suturing the wound* as soon as it is reasonable to expect nature to heal it.

The four processes, then, which make up the complete system are:

I. The Mechanical Cleansing of the Wound—*Débridement.*
II. The Chemical Cleansing of the Wound—The Administration of the Dakin Solution.
III. The Bacteriological Examination of the Wound.
IV. The Suturing of the Wound When Sterile.

I. DÉBRIDEMENT

The mechanical cleansing of the wound is a surgical operation to which Dr. Carrel has given the name, *"débridement."* This is a French word meaning, in the words of the International Dictionary, "Operation of removing by an incision any part which causes obstruction or prevents escape of pus." This operation, however, as applied here, involves a little more than the above

definition implies, for by *"débridement"* Dr. Carrel means a very thorough, delicate, and rigidly aseptic removal from the wound at the very earliest possible moment of all foreign material, infected tissue, injured tissue, which might easily become infected, and also as much good tissue as might stand in the way of the thorough application of the Dakin solution to absolutely every part of the wound. When a wound has been "debrided," then, as much of its infection has been removed as is practicable by means of pure surgery and, so far as the eye can see, it contains nothing but living, healthy tissue. In fact, cultures from this wound might show it to be sterile because infection usually does not develop and become active for a day or two.

II. THE ADMINISTRATION OF THE DAKIN SOLUTION

1. The Dressing of the Wound

The first step in the dressing of the "debrided" wound is to *protect the skin* surrounding it against the drainage of excretions which will accompany the treatment which is to follow. This is done by covering it carefully with *strips of gauze impregnated with vaseline.* This gauze should carry plenty of vaseline and it should be pressed down smoothly and closely upon the skin so that the drainage cannot run under it.

Next, *the tubes for the delivery of the solution are inserted.* In order to meet the needs of various wounds, as determined by their shape, location, and general character, Dr. Carrel designed a variety of delivery tubes (Fig. 124), using for them a soft rubber tubing of about the No. 14 or 15 French-scale size, and cutting it into lengths ranging from 12 to 16 inches.

Tubes A^1 and A^2 of Fig. 124 have one end closed—A^1 by tying as near as possible to the end with a strong thread (linen preferably), and A^2 by taking two short stitches at right angles over the end. Then, with a sharp punch about ½ millimeter in diameter (Fig. 125), these tubes are perforated for distances varying from two to eight inches (depending upon the extent of the wound) from the tied end, care being taken to distribute the perforations as evenly as possible, and about 4 holes being made to the inch. Tube B is either tube A^1 or A^2 wound, bandage fashion, with a strip of soft gauze, the amount of gauze varying with the size of the wound, and the precaution is usually taken of stitching one end of this gauze to the tube to prevent its being

lost in the wound. Tube C has both ends open with one end cut at an angle and a small hole cut a short distance from this end making the tube resemble an open-end rectal tube. Tube D is about twice as long as the others, is perforated in the middle instead of at the end, and its ends are connected to a glass Y-tube.

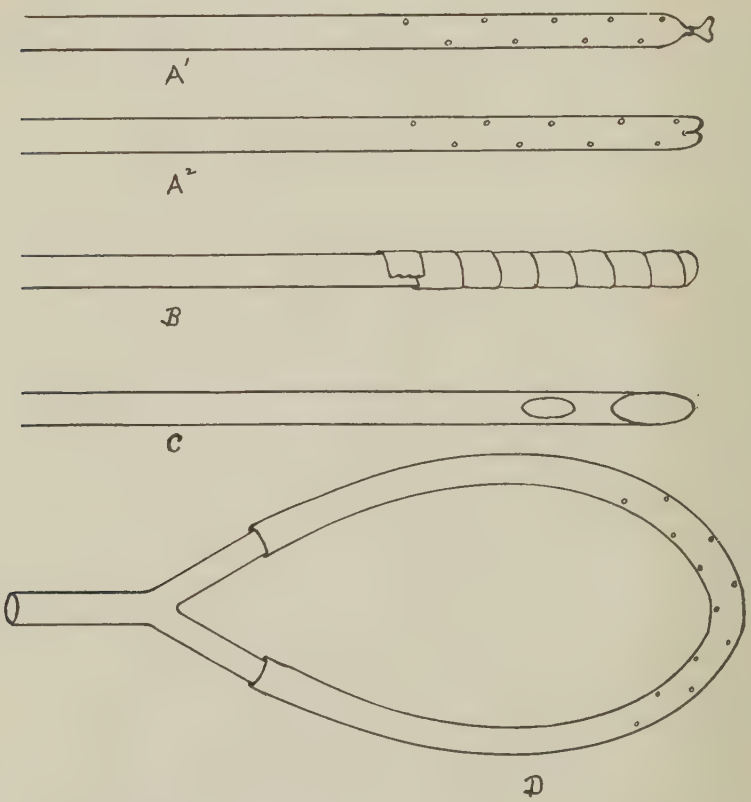


Fig. 124.—The Rubber Delivery Tubes. A^1, closed at the end by tying; A^2, closed at the end by stitching; *B*, made the same as A^1 *or* A^2 and afterward wrapped with gauze; *C*, the end cut at an angle and a large opening cut in one side near this end; *D*, a longer tube perforated in the middle, and connected at the ends to a glass Y-tube.

In Fig. 126 these several tubes are shown in place in the *types of wounds* for which they are best adapted. In wounds A, B, and C gauze is sometimes packed loosely around the tubes, and in wound D, which is a superficial one, a layer or two of gauze is placed under the tube.

Then, the tubes having been carefully placed so as to reach every nook and corner of the wound, *dressings are applied* about them and adjusted so as to keep them in place and allow convenient access to them. To prevent undue evaporation of the solution which is to be instilled into the wound, as well as to protect the patient's bed and clothing, it is advisable to use a pad of non-absorbent cotton over the gauze dressings. This should be split or punctured so as to allow the delivery tubes to pass

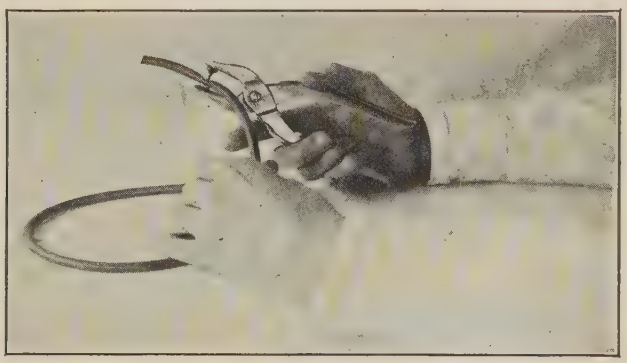


Fig. 125.—The Way to Perforate the Wound Tube. This particular punch is made for the purpose, but any similar one which makes a hole about ½ millimeter in diameter will do. Two holes are made at a time in this way at directly opposite points on the walls of the tube. The next two will be made at a distance of about half an inch from these, and in a line at right angles to theirs.

outward through it rather than under it because this will keep the tubes in place better and it will also protect the patient from any leakage which may occur from the mouth of the tubes.

The dressings are then, of course, secured by bandages, or in some cases by tape or webbing straps which can be tied in place. *Dressings for Carrel-Dakin cases should not be fastened quite so tightly* as is permissible with most other dressings because they will deliver the solution better when loose and, furthermore, the bandages sometimes shrink a little if they become wet.

2. The Instillation of the Dakin Solution

There are several methods by which the solution may be introduced into the wound. Sometimes *the elevated reservoir* (the ordinary irrigator) is permanently connected to the instillation

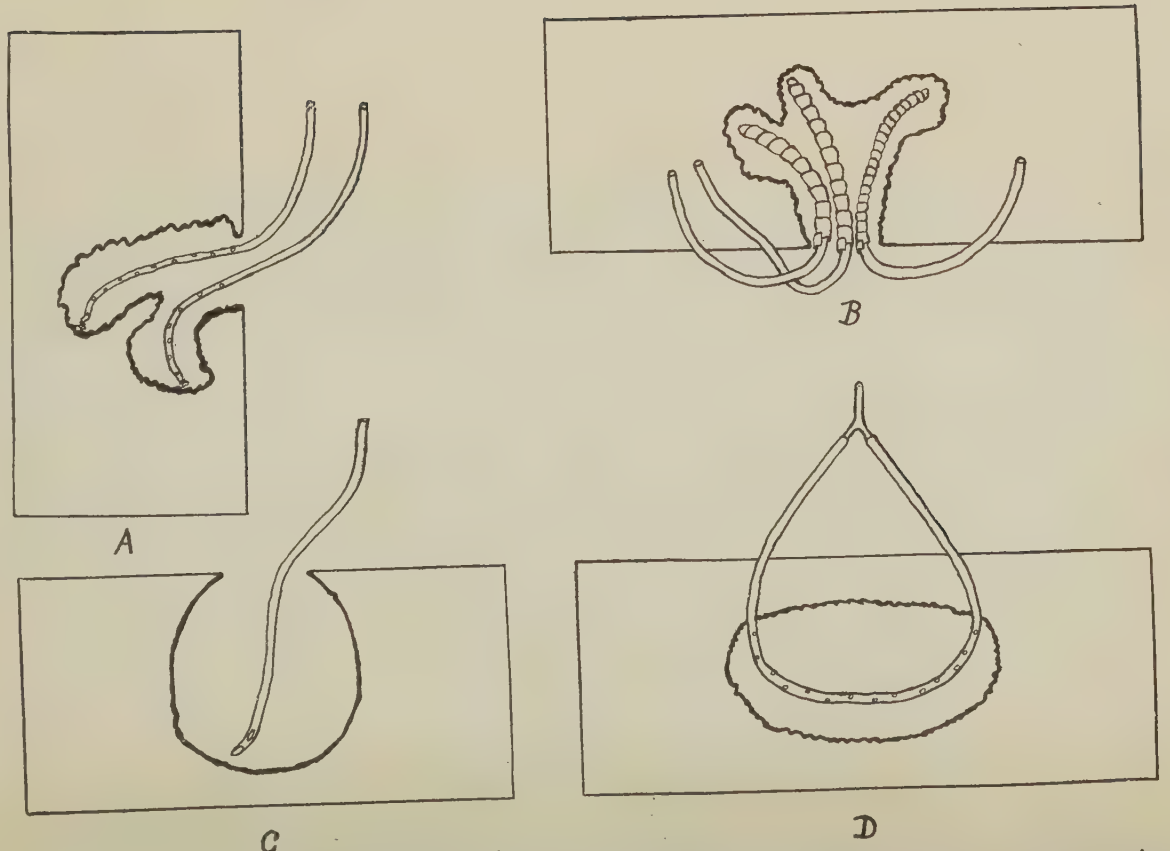


FIG. 126.—FOUR POSITIONS OF WOUNDS WITH THE APPROPRIATE WOUND TUBES IN THEM. *A*, wound opening on the side of a part, as on the side of the leg, with tube *A* in place; *B*, wound opening on the lower surface of a part, as on the back of the leg, with tube *B* in place; *C*, cup-shaped wound opening on the top of a part with tube *C* in place; *D*, top view of a horizontal surface wound with tube *D* in place.

tubes in some such way as that indicated by Figs. 127 and 128, and the solution allowed to flow by releasing a stopcock (Fig. 129) periodically, or, the glass dropper tube (Fig. 130) which is sometimes used for the Murphy drip may be used in series with the stopcock and the solution allowed to drop continuously at the proper rate. With the glass connecting and distributing tubes illustrated in Fig. 131 any number of wound tubes may be connected to the same irrigator by adaptations of the example given in Fig. 128. Instead of the reservoir for the intermittent

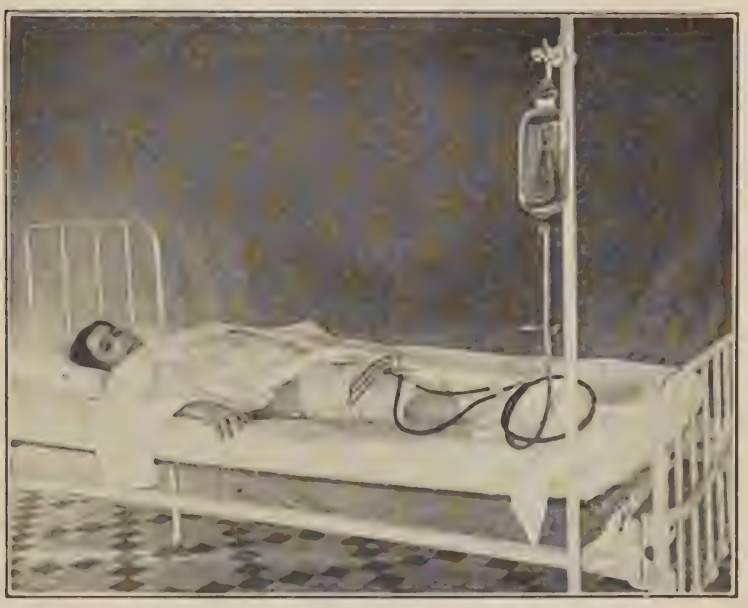


FIG. 127.—ARRANGEMENT OF THE APPARATUS FOR THE RESERVOIR METHOD OF INSTILLATION.

treatment, especially when there are only a few wound tubes, a glass syringe (Fig. 132) with a capacity of about two ounces may be used. If the wound tubes are accessible this may be used on them individually; otherwise it may be applied where the reservoir is attached in the arrangement suggested in Fig. 128.

The standard practice is to *administer the solution every two hours*, day and night. This frequency is determined by the fact that the Dakin solution is unstable and loses its sterilizing power by the end of this period. The mechanism of instillation should be so adjusted that, with average care, the treatment can be

given without any disturbance or discomfort to the patient, and it can thus be as easily carried out during the night as in the daytime. This is a very merciful feature of the method because this is one treatment which is never interrupted. The importance of *regularity* and *punctuality* in the instillation is one of the most urgent points for the beginner to learn. Another important point to be learned early is to *pay close attention to the amount*, as nearly as possible, of the solution which is required fully to bathe each individual wound and then faithfully give just that

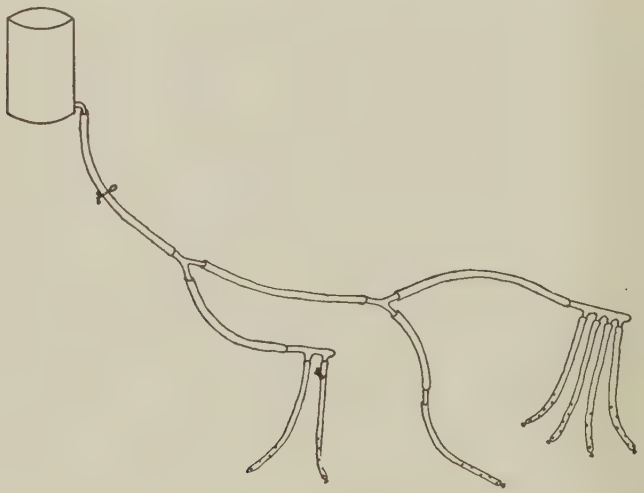


Fig. 128.—Suggested Ways of Branching the Main Supply Tube so that It Can Feed the Tubes of More Than One Wound, or Widely Scattered and Variously Grouped Tubes in the Same Wound.

amount. If too little is given the germs in the parts of the wound unbathed flourish unhindered and indefinitely; if too much is given it may not all be absorbed before the next instillation and the old, useless solution blocks the way for the new. Another menace of too great a quantity is the discomfort, and even injury, to the patient which results from the solution being spilled over healthy surroundings of the wound or onto the bedding and causing irritation of the patient's skin. In some instances the surgeon will, when he has finished the *débridement*, estimate, or even measure, the correct dosage for that particular wound and prescribe this exact amount for each instillation. Otherwise,

one or two instillations will be enough to teach one the proper quantity for a given wound.

The reservoir and stopcock method require great care on the part of the nurse, not only as to regulation of the dose but also as to the avoidance of sudden and forceful instillation which will be painful to the patient. With the syringe method the problem will sometimes arise of preventing an outflow of solution from dependent tubes. If the situation is such that the mouths of these tubes cannot be kept above the level of the wound by propping with the dressing, pinning to the dressing, etc., some such arrangement as that of Fig. 128 may be used, and if necessary the main tube may be kept clamped shut between instillations.

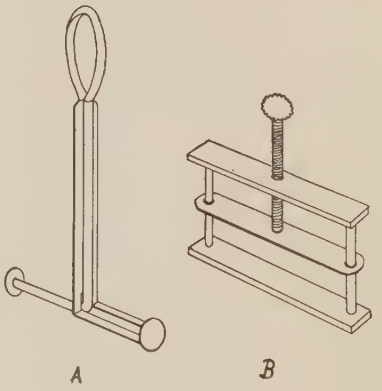


FIG. 129.—STOPCOCKS FOR USE ON THE SUPPLY TUBING IN THE RESERVOIR METHOD OF ADMINISTERING THE DAKIN SOLUTION. *A*, metal spring variety, suitable for the intermittent method, as it always entirely closes off the tube; *B*, screw variety, suitable for the continuous method of instillation, as the rate of flow of the solution can be very exactly controlled with it.

III. THE BACTERIOLOGICAL EXAMINATION OF THE WOUND

After the lapse of a day or two, during which time the treatment has been going on, of course, a system of microscopical examinations of the wound excretions is instituted.

A platinum wire loop of standard size is used to take up the excretion from the various parts of the wound which are believed to be most infected; this material is then spread upon a slide and put through the usual technical process for preparing microscopical slides. Under the microscope *a count is made of the number of bacteria* in a given field and the result is recorded on a tracing chart similar to those on which nurses trace temperatures. This test is *repeated periodically*, usually every second day, until there have been three successive examinations in which no germs were seen, when the wound is considered sterile and ready for nature to heal.

The first smear or two may not show much decrease in the number of germs, but after that there should be a gradual decrease, and the zero mark on the chart is reached in from a few days to several weeks, depending upon the severity of the injury and upon the type of tissue involved; that is, whether it is the soft parts of the body, bone, etc.

FIG. 130.—GLASS DROPPER TUBE FOR USE ON THE MAIN SUPPLY TUBE IN THE RESERVOIR CONTINUOUS METHOD. The solution cannot pass through this tube faster than drop by drop, and the rate at which it is dropping can be readily observed at all times.

If the expected downward course of the count does not take place promptly *all possible causes should be investigated,* and the trouble will usually be traced to one or more of the following causes:

1. Incomplete *débridement.*
2. Incorrectly placed delivery tubes.
3. Insufficient number of delivery tubes.
4. Insufficient amount of instillation.
5. Faulty adjustment of dressings.
6. Flaw in technic somewhere along the line from *débridement* to instillation.

The surgeon or the pathologist will do this bacteriological part of the technic, though there may be cases in which the nurse will be called upon to take the smear from the wound. It should not be necessary to remind the nurse that the *strictest aseptic technic* must be observed in this act, and that the slide must be carefully protected from contamination until delivered to the pathologist.

The smears should be taken at the *same hour each day;* not sooner than *two hours after an instillation;* and the various operations from the taking of the smear to the counting of the germs should be *done by the same person* or persons throughout the course for a given case, so as to eliminate all variations due to causes outside of the wound itself.

IV. THE SUTURING OF THE WOUND

When three successive smears have shown no germs the surgeon then sutures the wound, which should heal uneventfully.

It must not be forgotten, however, that this *sterilized wound is not yet safe*, but that it may be reinfected unless the rigid asepsis is maintained until healing is complete.

Disposal of Used Delivery Tubes

If in good condition these *tubes may be used again*, but the greatest care must be exercised in the re-preparation of them.

Immediately upon removal from the wound the *tubes should be stored in some antiseptic solution.* If this is not possible

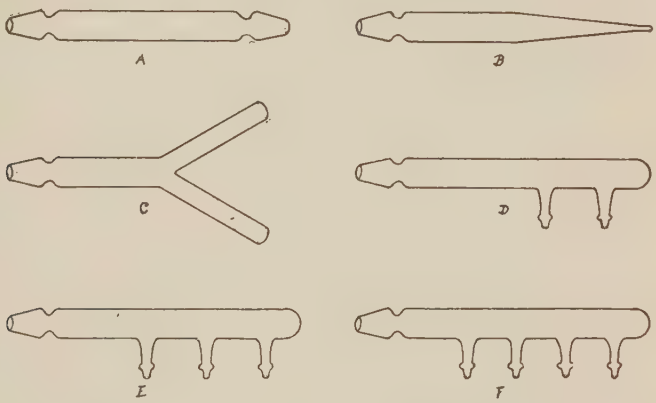


FIG. 131.—GLASS CONNECTING AND DISTRIBUTING TUBES. *A*, ordinary straight splicing tube; *B*, suitable for conecting rubber tubes of different calibers, as in the case of uniting one of the small wound tubes directly to the main supply tube. This tube also answers as a dropper tube in place of the special one illustrated in Fig. 130; *C*, Y-tube for making various bifurcations in the main supply tube; *D*, *E*, and *F*, 2-, 3-, and 4-way tubes for connecting the wound tubes with the supply tube.

immediately they should at least be put into a basin of saline solution or even plain water, because if they are allowed to become dry before washing it will often be very difficult to get them clean. Any antiseptic solution which will not injure rubber will do, such as lysol or carbolic. Dakin's solution may be used, of course, but unless one's supply is very abundant this is more extravagant than necessary.

In any case, the *tubes should be allowed to soak for several hours* in the antiseptic solution before anyone is asked to handle them for washing. It is probably true, however, that these tubes are not greatly infected, particularly on the inside, because of

the fact that they have constantly been in contact with the Dakin solution while in the wound.

Nevertheless, *rubber gloves should be worn when washing them,* and care should be taken not to splash the wash water into the eyes, mouth, etc. This point may seem an unnecessary one to remind nurses of, for they learn early in their work to beware of such accidents, but this is a peculiar case because of the fact that, in order to get the tubes clean on the inside, it is necessary (for they are tied shut at one end) to struggle considerably with them while holding them stretched out enough to enlarge the perforations sufficiently to allow what is inside to

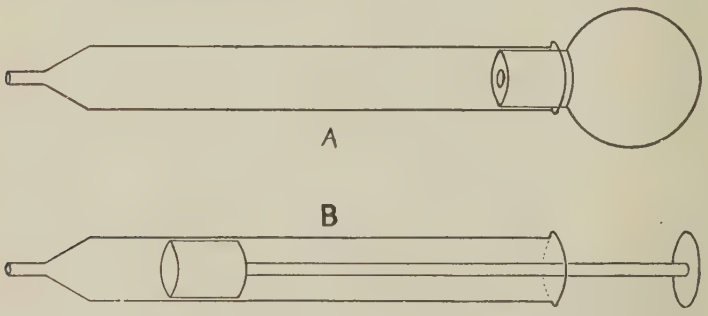


FIG. 132.—GLASS SYRINGES FOR ADMINISTERING THE DAKIN SOLUTION. *A,* rubber bulb type which may be operated with one hand—the more convenient one for the purpose; *B,* the plunger type.

be washed out. They will inevitably snap out of one's fingers repeatedly and should not be able to splash anything about which is not reasonably clean. Clear *running water* should be used first in the washing, and then *soap and water.* The use of a forceful syringe is an advantage at this stage. After a thorough rinsing the tubes are ready for the *final boiling.*

The Dakin Solution

Dakin's solution is a 0.45 to 0.50 per cent. solution of *sodium hypochlorite.* Its accurate compounding requires a very exact and technical chemical process but it is interesting to know that it may be made from these three familiar chemicals: Chlorinated lime, carbonate of soda (washing soda), and bicarbonate of soda.

Chlorine, which is the all-important element in the solution, is one of the most active of the chemical elements, especially where

animal and vegetable matter are involved, and so, first of all, Dakin's solution is an *active germicide.* Then, by virtue of the same power with which it kills germs so effectively, combined with its isotonicity (about which you learned on page 402), it also acts upon all other organic substances, and so we find it *dissolving blood clots, pus, tissue waste,* etc., in the wounds. This is a very important fact to know because the solution of a blood clot may entail a hemorrhage as may also the solution of waste tissue. This should be kept in mind at all times when administering the treatment.

Furthermore, of particular importance to the nurse is the fact that this same *chlorine will destroy, in time, many other materials* with which it might come into contact while she is using it —personal clothing, bedding, etc. You are familiar with Javelle water (bleaching solution) and with Labarraque's fluid, and since Dakin's solution, by virtue of its chlorine, is a close relative of these solutions you can understand something of its action in this respect.

However, with all this germicidal and solvent power this solution, in the exact per cent. of strength given above, is only *very slightly irritating.*

Dakin's solution is also a deodorant. Perhaps one of the first points that a nurse will note about her first Dakinized wound is that, where otherwise there would be an offensive odor of pus, there is only the fresh, clean odor of chlorine.

Another graceful service which this highly accomplished solution renders is to *beautify the wound* into a healthful-appearing, rich, red color.

In handling and storing the Dakin solution it must be remembered that *it is an unstable chemical,* especially when exposed to the chemical action of light, and for this reason care should always be taken to keep it well corked, away from the light, and to use none but a freshly prepared solution.

Since the introduction of the Carrel-Dakin treatment there have been numerous efforts made to manufacture a "just as good" solution which would be more stable than the Dakin solution. Dr. Dakin himself made several oil solutions—Chloramin-T, Dichloramin-T, etc.—and "hychlorite," "zonite," etc., are commercial similarities.

CHAPTER XXI

BANDAGING

The subject of bandaging is one which can be disposed of with a few arbitrary demonstrations, and some pupils can be trained thus into dextrous bandagers; but on the whole, time can be saved and more intelligent skill attained if demonstration and practice are reserved till a general survey of the field has been made from the more purely theoretical standpoint.

There are certain principles involved which must be observed in all bandaging that is worthy of the name, and a knowledge of them should precede practice so that bad habits (always hard to eradicate) will not get a foothold.

DEFINITIONS

A *bandage* may be defined as a piece of flexible material suitably fashioned for application about something as a covering, a reinforcement, or a compressor.

The term *bandaging* will then mean the art of applying the bandage for any of these purposes.

USES OF BANDAGES

The purposes for which bandages are used may be summed up under these headings:

1. *To hold dressings, splints, and other appliances in place.*
2. *For support,* as in the case of a sprained joint, etc.
3. *For pressure,* as in the case of a bleeding vessel, etc.

The specific uses are too numerous to mention here, and they will be readily gathered in the following pages.

FORMS OF BANDAGES

Under the general definition the bandage may be of a great number of forms, but those in more common and standard use are: (a) *The Roller Bandage,* (b) *The Triangular Bandage,* (c) *The Many-Tailed Bandage.*

(a) *The Roller Bandage* is merely the bandage material which has been cut into a long, narrow strip and rolled up, from one end to the other, into a compact cylinder so that it may be more easily and quickly handled and used.

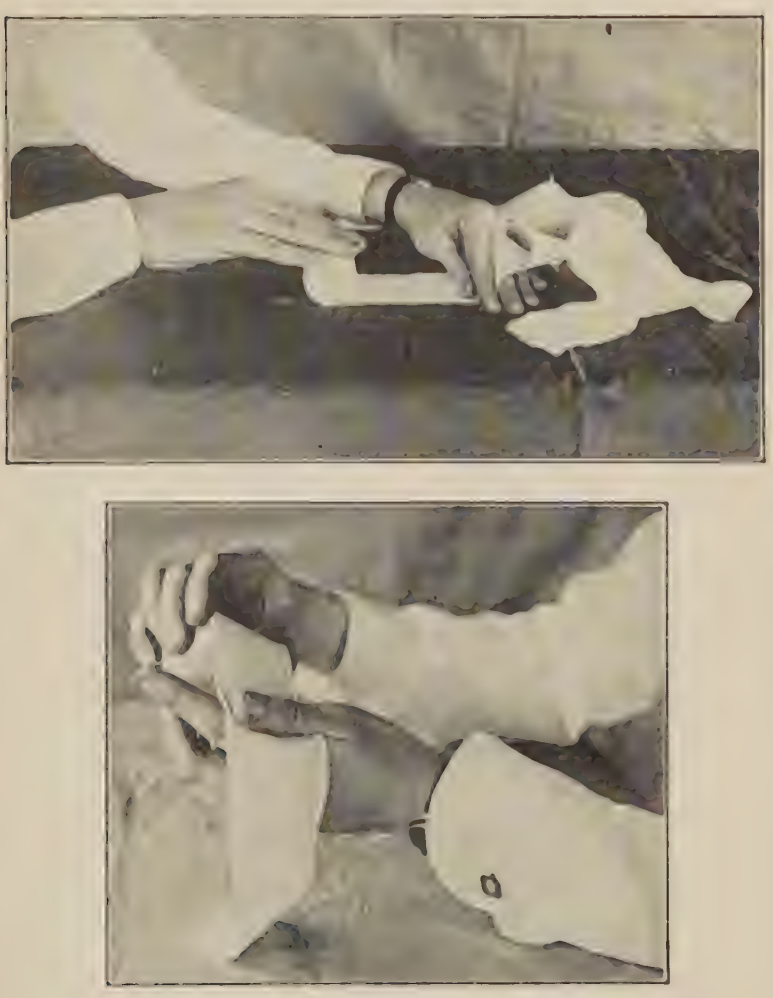


Fig. 133—Two Methods of Rolling a Bandage by Hand.

The market supplies these bandages in all materials and sizes ready for use, but there will be occasions when these will not be available and every student should learn the several methods for preparing them. There are numerous hand machines for

rolling bandages, and the nurse will have access to these in most hospitals, but as a preparation against the times when she will be out of reach of machines she should practice one or both of the *hand methods* illustrated in Fig. 133. This is really a simple thing to do and the only points to bear in mind about it

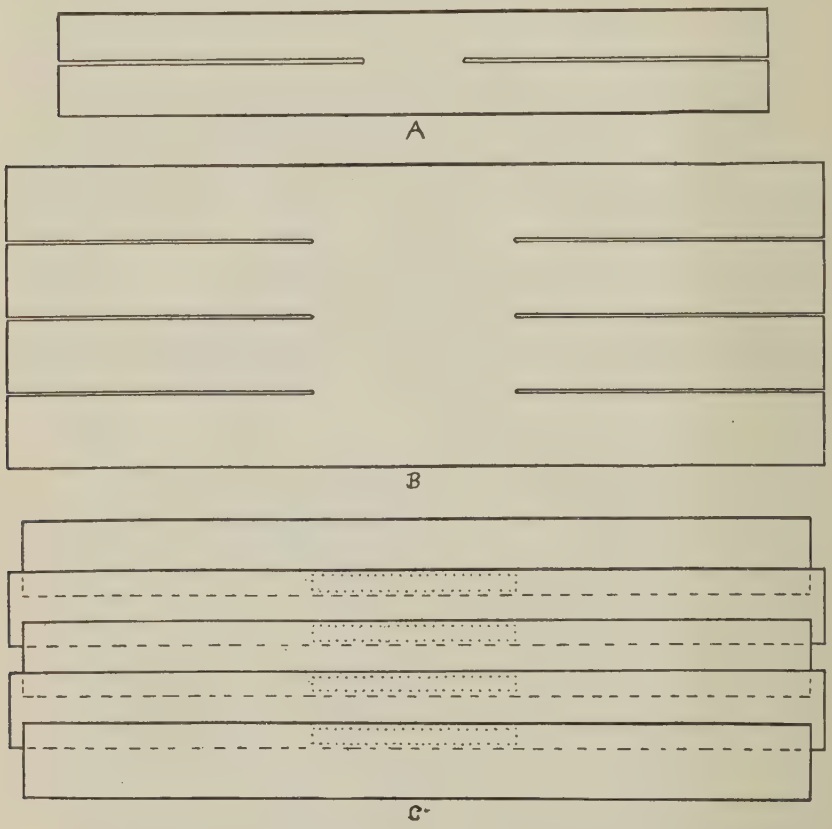


Fig. 134.—Many-Tailed Bandages. *A* and *B*, the simple design made by splitting the ends of an oblong piece of material; *C*, the Scultetus bandage or binder made from strips of material lapped one upon the other and stitched together for a short distance in the middle.

are that a solidly rolled bandage is much more satisfactorily applied than a softly rolled one, and that to secure a solidly rolled one it must be very compactly rolled from the very beginning because the whole will have no more body in the end than its core.

The roller bandage is by far the more commonly used one,

and the one which is adaptable to the greatest variety of purposes.

(b) *The Triangular Bandage* is simply a three-cornered piece of material the shape of the half of a square which has been cut from one corner to the diagonally opposite one, or which has been folded double along this line. Aside from one or two uses which will be encountered later, this bandage will be employed only as a substitute for the roller bandage in emergency cases, as it is more easily and quickly improvised than the roller one.

(c) *The Many-Tailed Bandage* (Fig. 134) is made in a number of slightly varying designs but consists essentially either of a single oblong piece of material which has been split at each end into two or more tails (A and B of the illustration), or of a combination of two or more strips whose edges have been overlapped and stitched together in the middle, leaving the ends free (C of the illustration). The particular type C is commonly known as the *Scultetus bandage* or binder. The many-tailed bandage serves few purposes for which the roller bandage will not be preferred, but it has wide application and constitutes a very serviceable emergency form because it is simple to make and easy to apply.

MATERIALS USED FOR BANDAGES

It would be impossible to give an exhaustive list of the materials from which bandages are made because there is scarcely any limiting requisite except that of flexibility. However, the more or less standard ones for the three forms of bandages are as follows:

(a) *Roller Bandage*

Gauze
Muslin
Canton flannel
Woolen flannel
"Elastic" webbing (woven cotton bandage)
Rubber
Crinoline impregnated with starch—the "starch bandage."
Crinoline impregnated with plaster of Paris—the "plaster of Paris bandage"
Crêpe paper

Gauze is the most frequently used material. Its advantages are that it is light in weight, cool, and so flexible that it is easily fitted to all parts. It cannot be washed or used a second time with satisfaction and is therefore a relatively expensive material.

Muslin is very suitable where greater strength is needed, as in the application of the larger splints, in the arrest of hemorrhage, and in other cases where more pressure is required than gauze will supply. It withstands washing and repeated usage.

Canton flannel, because of its combined softness to the touch and its strength, is often used where pressure is necessary over a sensitive part. It is also useful as padding underneath a plaster or starch bandage.

Woolen flannel is used chiefly for its softness of texture. It, too, is washable and can be used repeatedly.

"Elastic" webbing is a specially woven cotton material which furnishes the advantages of the adaptability, and a large part of the lightness, of the gauze, a measure of the strength of the muslin, the softness of the flannel, and the elasticity of the rubber. As a substitute for the rubber this bandage has the very desirable superiority of being highly porous but its strength is considerably less.

The *rubber* bandage, commonly known as the "Esmarch," is made of gum rubber. It is used as a pressure or constricting bandage for the arrest of hemorrhage, or for special treatment (see page 447).

The *starch* bandage is merely crinoline which has been saturated with a boiled solution of starch, and rolled loosely after it has become dry. It is softened again in warm water for application, and when it has dried in place it constitutes a fairly rigid and relatively light cast or splint. It will be used for the immobilization of fractured or otherwise injured parts.

Plaster of Paris bandages are made of crinoline into which has been rubbed as much plaster of Paris as it will hold. They are applied wet and in numerous layers, and when they have dried they make a very rigid, strong, and heavy encasement or splint. They are used where complete immobilization of the part is needed, particularly for fractures.

The nurse may need *to make plaster of Paris bandages* occasionally, and to do so she will proceed thus: Tear the crinoline

the desired size (see under "Sizes of Bandages," page 420), and remove all ravelings; pour a large quantity of plaster in a heap upon a smooth table; lay one end of the bandage upon this, brush a handful of plaster over it, rub firmly and smoothly with the hand two or three times and then roll the finished portion carefully and loosely (Fig. 135). Proceed thus, rolling up each section of a few inches as fast as it is ready and handling very carefully so as not to undo what has been done. Substitutes for the hand, such as a wooden spatula, have been tried for rubbing in the plaster, and machines for the whole process have been contrived, but the hand is the best instrument in that it causes

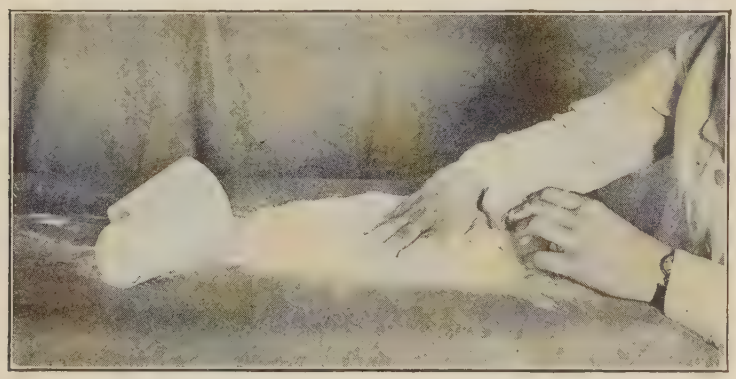


FIG. 135.—METHOD OF MAKING PLASTER OF PARIS BANDAGES. Note the large quantity of plaster in use, which is necessary for best results.

less friction and jarring and therefore produces a more smoothly and evenly impregnated bandage. Use plenty of plaster as you rub, brushing off the excess immediately before rolling the finished part. Wrap each bandage securely in paper as soon as it is finished. The wrapper not only makes the handling of the bandages easier and pleasanter, but it also prevents the sifting of the plaster about where it is not wanted.

Crêpe paper makes a very light bandage, and as it does not possess much strength it will be useful only where very slight protection for dressings is needed.

(b) *Triangular Bandage*

Muslin is the usual material for this bandage, but any similar material will, of course, serve as well.

(c) *Many-Tailed Bandage*

Muslin and Canton flannel will be used for this bandage, the choice depending upon the purpose it is to serve and the part to which it is applied.

SIZES OF BANDAGES

(a) *The Roller Bandage*

The *length* of the factory-rolled gauze bandage is usually 10 yards, and that of the muslin and flannel ones 5 yards. These have proved to be the most serviceable lengths on the whole, for these materials, the greater length being needed in the gauze because of its lighter weight and inferior strength which necessitate the use of more layers of it. The crinoline for the starch and plaster of Paris bandages may be of any length, but it is wise to vary the length with the width—that is, the narrower ones need not be as long as the wider ones.

The *width* of the roller bandage will depend upon the part to which it is applied and will vary roughly as follows:

Finger	¾ to 1 inch
Hand and arm	1½ to 2½ inches
Foot and leg	1½ to 3 inches
Hip	3 to 4 inches
Body (chest and abdomen)	3 to 5 inches

(b) *The Triangular Bandage*

This bandage will vary in *size* with the part upon which it is used and will be in general as follows:

Arm (the sling)	the half of 1 square yard
Hand	the quarter of the sling
Foot	the half of the sling
Head	the half of the sling
Shoulder	the half of 1 square yard
Hip	the half of 1 square yard

(c) *The Many-Tailed Bandage*

It will not be very helpful to prescribe dimensions for this bandage as it will need to be fitted to each patient, and the illustrations in Fig. 166, page 446, will guide the student as to the proper measurements to make.

PRINCIPLES OF BANDAGING

Before we undertake to apply a bandage we should adopt as our fixed, guiding influences these three principles of the art:

1. *Evenness of Pressure*
2. *Durability*
3. *Neatness*

These principles are stated in the order of their importance, and in the order in which they should be put into effect by the beginner, but one may not call herself a finished practitioner until she is able to observe the three simultaneously. They scarcely need elucidation, but a few important details pertaining to each of them, which the student should be reminded of, are as follows:

1. **Evenness of Pressure.**—Every bandage must exert a certain amount of pressure, depending upon the part to which it is applied and the purpose which it is to serve. A bony part, such as the skull will need and endure, in general, more pressure than a yielding part, such as the hand; and a bandage applied to compress a bleeding vessel must, of course, exert more pressure than one which serves the mere purpose of keeping a dressing in place. *Much practice* is the only means of acquiring good judgment as to the suitable amount of pressure for any given case, and this must always be guided by an intelligent comprehension of the object of the treatment and the condition of the part bandaged, and by due consideration for the patient's immediate and future comfort.

Whatever the tension of the bandage, however, the important point, from all standpoints, is that it should be equal throughout, because very serious results may follow otherwise. In the first place, a bandage which constricts in lines here and there is very *uncomfortable.* This objection will often take care of itself, however, through the complaint of the patient; but the really serious damage is done in those cases where the part was previously so painful throughout or so subnormally sensitive for some reason that the patient does not accuse the bandage. In these instances the unevenly-applied bandage may so constrict blood vessels and compress nerves as to cause *gangrene or paralysis* in the part.

Of course, a bandaged part is always kept under observation,

but the best precaution against accidents from unevenness of pressure is plenty of diligent practice with the bandage.

2. **Durability.**—The importance of durability in an applied bandage is so self-evident as to need no comment, except, perhaps, the reminder that an unstable bandage is usually a very *uncomfortable* thing to wear.

When one has learned the first principle well she has progressed a long way toward the secret of this second one. That is, a bandage which is *evenly applied*, within the limitations of reasonably good pressure, is more likely to stay in place than the uneven one. However, the problem of durability involves much more than this and it is perhaps not an exaggeration to say that excellence is harder to attain under this principle than under either of the other two.

Much may be accomplished as to durability by placing the part in its *customary position* or in the desired permanent one before applying the bandage, because muscular motion underneath a bandage will surely disarrange it more or less.

Finally, faithfulness to the *method customary* for the part or purpose will be of great importance because experience is responsible for the particular method and it will be rare that the best results will follow any considerable departure from the advice of long experience. These various methods will be taken up a few pages hence and the student will do well when she reaches them to accord them a special mark of respect for the sake of this principle of durability.

3. **Neatness.**—This last principle is very unproverbial in that it is also the least. However, though they do not rank high as objects of beauty, most of the standard applied bandages do admit of some artistic merit and every student should aim to do them all the justice possible in this respect. Neatness should be kept in mind with the other two important principles from the very beginning, because with practice they will operate very well in unison, and if careless habits are once formed, it will be hard to inject a new element into them.

MODES OF APPLYING THE ROLLER BANDAGE

There are these five recognized modes of applying the roller bandage to the several parts of the body:

1. *Circular*
2. *Spiral*
3. *Reverse*
4. *Figure-of-8*
5. *Recurrent*

Each one of these modes has its reason for existence in some peculiar adaptability to a part, in a special suitability for some purpose, or in a combination of the two. Very few applied bandages, however, are pure examples of one mode, for the complexity of design in the human framework calls for a compound of two or more of them in the great majority of cases. It will be helpful for the student, nevertheless, to study each of these

Fig. 136.—The Way to Grasp the Roller Bandage Preparatory to Applying It.

five elementary designs individually because she will acquire thereby both synthetical and analytical power in the work which will make it at the same time more intelligible and more interesting to her. Accordingly, we shall pause here to present each of the five modes in a simple detailed example, and if the student will take this discussion seriously she will save herself much floundering when she comes, a few pages hence, to the necessarily more unorganized presentation of bandaging as applied in the average everyday practice.

First of all, the part to be bandaged is arranged in the position which is to be permanent for it; the bandager takes a position in front of the patient, as a rule (exceptions will be discovered later); and the bandage is then disposed in the hands as illustrated in Fig. 136—that is, one hand prepares to place and keep the free end where it belongs and the other to control the unwinding of the bandage as it is applied. We then study the five different modes thus:

1. **Circular Mode.**—*The head* is one of the subjects for this type of bandage, and so with both hands we lay the bandage

Fig. 137.—The Way to Begin the Application of the Roller Bandage.

against the forehead (Fig. 137), a small portion having been unrolled for ease in properly locating it. The free end is held against the temple with the one hand while with the other the bandage is rolled around the circumference of the head with even and firm tension till it reaches the free end, when it is continued over this and around the head again in exactly the same track. After the end has been secured, the hand which held it will be released, of course, to assist the other one by carrying the roll around on its side of the head. When the roll reaches

the location of the free end the second time we have a circle of two layers of bandage around the head (Fig. 138), and have thus secured by friction and stress, or, in other words, have *"anchored,"* our bandage; and at the same time we have applied the amount of bandage which may be taken as a *standard foundation*—that is, two layers. This will rarely ever constitute a complete piece of bandaging, but it does enter into nearly

FIG. 138.—THE CIRCULAR MODE OF BANDAGING. The usual anchorage for the applied roller bandage.

every bandage as the means of both anchoring it in the beginning and of securing it at the end.

2. **Spiral Mode.**—For this demonstration we shall select the *upper arm.* Grasp the bandage as before, lay it upon the arm near the elbow, and apply a circular bandage—that is, two layers, one directly upon the other, entirely around the arm. Then begin to travel upward with slow spiral turns of the bandage (Fig. 139), allowing each turn to cover at least one-third of the width of the previously-applied one. Keep in mind, as you do this, your *three principles,* maintaining the same tension on your bandage throughout, rolling the layers on smoothly

and at a stable angle (that is, not so great an angle that they will have a tendency to creep back), and make it as neat as you can by keeping the edges of every two layers parallel and by covering the same fraction of the width of the previous layer every time. Finished with two or more of the circular turns, this will make a complete design which is applicable only to such comparatively parallel-sided parts as some upper arms, the fingers, etc., or to similarly-shaped splints.

3. **Reverse Mode.**—The *forearm* is a suitable part upon which to demonstrate this mode because of its cone-like outline. It will be a good plan for the beginner to apply, first of all, a few turns of the spiral bandage to this part in order to learn at once why it will not answer (Fig. 140). She will see that it embodies an infraction of every one of the three principles of bandaging—that is, the two edges of the bandage exert unequal degrees of pressure, which is very clear from the fact that one of them is entirely free of tension in a part of every turn; it will not stay in place, as its appearance very clearly indicates and as a slight pull would demonstrate; and it certainly does not look neat. We can correct all these evils very easily, however, in this way:

Fig. 139.—The Spiral Mode of Bandaging.

Start just above the wrist with the now familiar circular bandage; then begin one of the spiral turns, but just as the lower edge of the bandage shows the objectionable *slack*, which is due to its having a shorter distance to cover than the other, *turn the roller upside down* (Fig. 141), thus making a twist in the bandage which uses up this slack and allows the bandage to lie flat for the remainder of the turn, when the same problem will arise and it will be solved in the same way for each turn until the part is covered. In the act of twisting, or *"reversing,"* the bandage, special care is required to avoid stretching it so tightly that it will be drawn into wrinkles instead of into

one flat fold. This is done by holding the applied bandage down with one hand just at the site of the reverse while the free part is allowed to slacken slightly for the moment of the reversal,

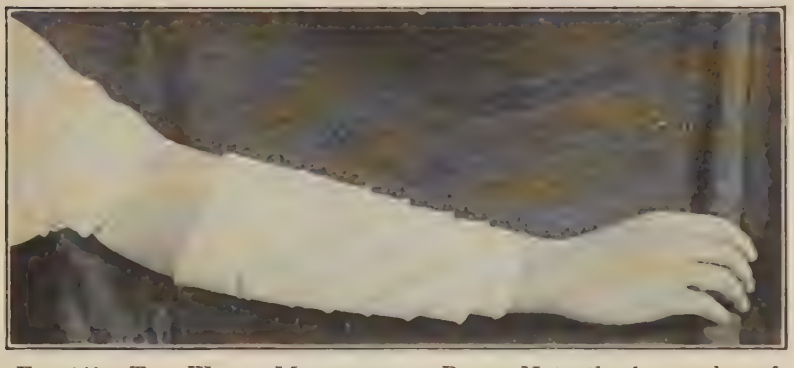


Fig. 140.—The Wrong Mode for the Part. Note the loose edge of each turn. The Spiral Mode will fit only a parallel-sided part.

Fig. 141.—The Way to Make a Reverse. The roller is now right side up because one reverse has already been made. After the next reverse it will be upside down again.

after which the usual tension is resumed for the next turn. This bandage will be secured at the end with the usual circular bandage.

A *great deal of practice* will be required before one can apply

the bandage well by this mode, and if it cannot be done well some other mode should be used instead for there are too many loopholes in it for offenses against all of the three principles of bandaging. It is a very suitable method, however, for tapering parts, such as the arm and leg, and if one wishes to become a versatile bandager she must learn it.

4. **Figure-of-8 Mode.**—*The ankle* furnishes us with a good subject for this mode of bandaging. Start, as usual, with the circular bandage as your anchorage, placing it around the foot

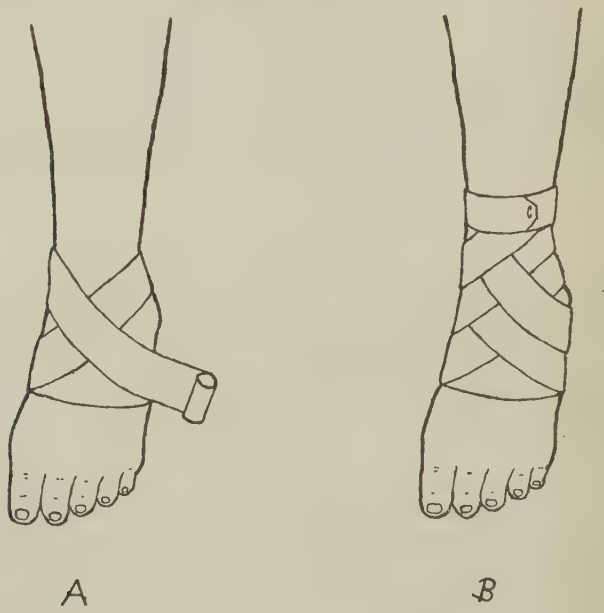


FIG. 142.—THE FIGURE-OF-8 MODE OF BANDAGING. *A*, the first turns; *B*, the completed bandage of the ankle.

just at the base of the arch; then pass the bandage in figure-of-8 style thus: Diagonally across the instep toward the base of the heel, around the back of the heel, and across the instep again in the other diagonal to the original circular bandage on the side opposite the starting point of the first diagonal (A of Fig. 142). This completes one figure-of-8 turn, and the bandage is continued simply by repeating this maneuver till the part is covered, lapping each turn over one-third or one-half of the width of the preceding one. If this is to constitute a com-

plete dressing it will be secured by the circular bandage around the ankle (B of Fig. 142).

Though the design of this bandage is not the simplest one to learn, aside from that it is one of the easiest modes with which to secure good results under all of the three principles. Durability is an especially prominent feature of the figure-of-8 bandage, and its appearance can be made to compete very favorably with that of any of the other modes.

The figure-of-8 design has a very wide application, being almost the only suitable one for the *joints of the body*, particularly the larger ones, such as the ankle, knee, hip, wrist, elbow, and shoulder; and it is also applicable, *in combination with the reverse mode*, in various other parts which will be indicated later.

Fig. 143.—The Recurrent Mode of Bandaging. The patient is holding the reverses in place at the back of the head. On a smaller part, such as the stump of a limb, the bandager can control the entire operation himself.

5. **Recurrent Mode.**—This is perhaps the most difficult mode to learn and it is also rather awkward to apply, in that it requires the assistance of a third hand when applied to the head, which is the most common subject for it. Often the patient himself will be able to lend this helping hand but if he cannot do this an assistant must be provided. As it will probably be the only available part for practice, we shall select the head for our subject. Pass a circular bandage around the head, as described in Mode 1, stopping at the middle of the forehead; then

reverse the bandage by the same maneuver as you used for the reverse mode (Fig. 141), and pass the roller backward across the middle of the head and down over the circular turn at the back, holding the fold of the reverse firmly in place with the thumb of the other hand meanwhile, and now asking the patient or the assistant to place his hand upon the intersection of the layers on the other side (Fig. 143). Repeat this process, back and forth, till the whole head is covered, working from the middle toward the sides alternately, and covering one-half of the previous layer each time (Fig. 144). In stationing the reverses it will be found possible and easiest to group them closely together (each immediately on top of the previous one) in the middle of either side rather than to distribute them along the circular bandage, as they can be more easily held in place this way and they will usually fit the part better thus. When the head has been entirely covered the bandage is again reversed to the direction of the original circular bandage and two more circular turns are passed around the head to secure the ends which you and your assistant have been holding.

FIG. 144.—COMPLETED RECURRENT BANDAGE. Note that the turns all lie flat, and that they converge toward the middle of the forehead, which means that the reverses are lying directly over one another, as they should do.

This makes a complete bandage which will often be used for the stump of a limb, the end of a finger, etc., as well as for the head.

As stated above, these are *elementary designs* which will be found in combinations of two or more oftener than alone, but we shall assume that the student has practiced them as advised, and in the following section shall build up the numerous complex designs very largely in terms of these modes without again going into the details of their structure.

THE APPLICATION OF BANDAGES TO THE VARIOUS PARTS OF THE BODY

(a) *The Roller Bandage*

Hand and Arm

It will be an unusual case in which a bandage will be applied to the fingers, the hand, and the entire arm at the same time; but the student's best plan is to combine these parts in one lesson and it will then be an easy matter for her to make the subtractions appropriate for any given case.

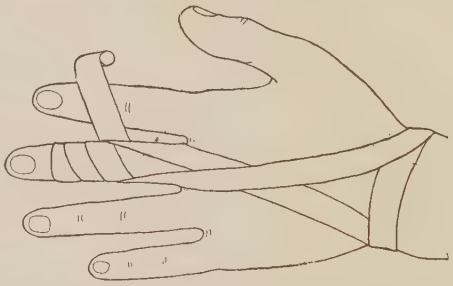


FIG. 145.—SPIRAL BANDAGE OF THE FINGER ANCHORED TO THE WRIST WITH A FIGURE-OF-8 AND A CIRCULAR TURN.

Either the spiral or the combination of the figure-of-8 and reverse modes will be found suitable for the *fingers,* with the introduction of the recurrent mode if the ends of the fingers are to be covered. As a rule, however, a finger bandage will not be durable unless it is connected with the wrist by means of a figure-of-8 and a circular bandage (Fig. 145), introduced after every second or third spiral turn. Each finger may, of course, be bandaged in this way separately, but in everyday practice it will be found that when two or more fingers need bandaging they will usually be combined in one dressing and bandaged together, in which case the method for a single finger will apply. In cases where all the fingers are involved they will usually be combined in a single large dressing and the suitable mode of bandaging them will then be the recurrent one (see Fig. 143, page 429). The finger bandage may be anchored either around the wrist or the end of the finger.

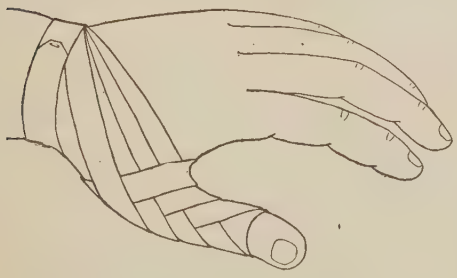


FIG. 146.—THE THUMB SPICA.

The *thumb* presents a somewhat different case from the fingers in that it is nearly always bandaged with what is termed the *"spica"* bandage (Fig. 146). This spica involves nothing new as to mode, for it is a pure figure-of-8, but it so happens that in the complete design the layers present the appearance of the spikes in a head of barley, and therefore the bandage has been given the distinctive name "spica." Though the term has its origin in the mere appearance of the completed bandage, "spica" always carries with it the meaning of a joint bandage because the figure-of-8 takes on this appearance in all cases of its application to a joint which connects an appendage to its trunk. The application of a thumb spica will present no new problem to the student, and we have emphasized it here only for the sake of introducing the term which will arise in several other cases later.

Whether or not the fingers and the thumb are involved, our method of procedure for the *hand and arm* will be this (Fig. 147): Begin about the palm with the circular bandage, then a spiral or two if necessary, and proceed with the figure-of-8 over the back

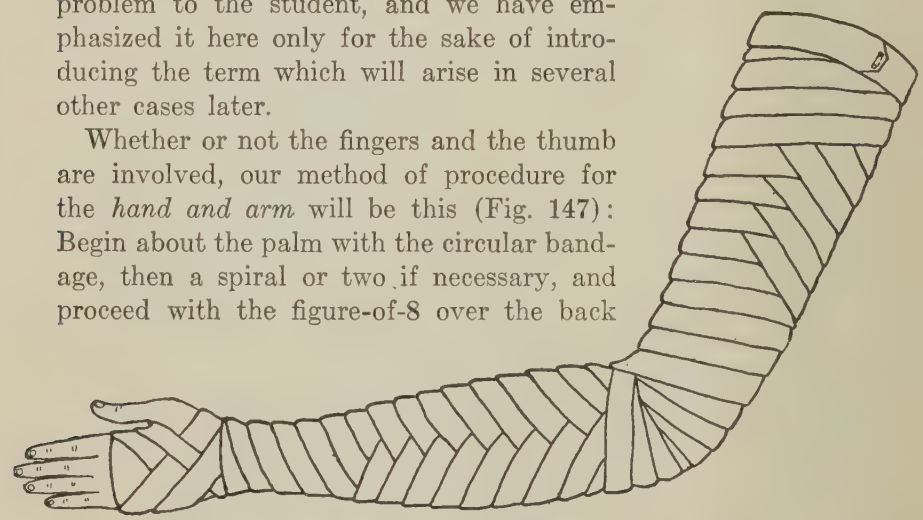


FIG. 147.—COMPLETE BANDAGE FOR THE HAND AND ARM.

of the hand and the wrist, around the wrist with the circular, upward over the cylindrical part of the forearm with the spiral, and thence with the reverse over the conical part to the elbow. The elbow (in a slightly flexed position) is then covered, directly over the joint, with two or three circular turns, several figure-of-8 turns (enough to cover it securely) are passed over this and about the joint, working upward and downward from the joint alternately. The upper arm is then covered with either the spiral or the reverse, depending upon whether it is of a general cylindrical shape or a conical one.

On the *shafts of the arm* a combination of the figure-of-8 and

the reverse modes are very suitable, the figure-of-8 being used as the theme and the reverse being introduced only when needed to keep the bandage lying flat and to equalize the tension of the edges, which will usually be every second turn (Fig. 148).

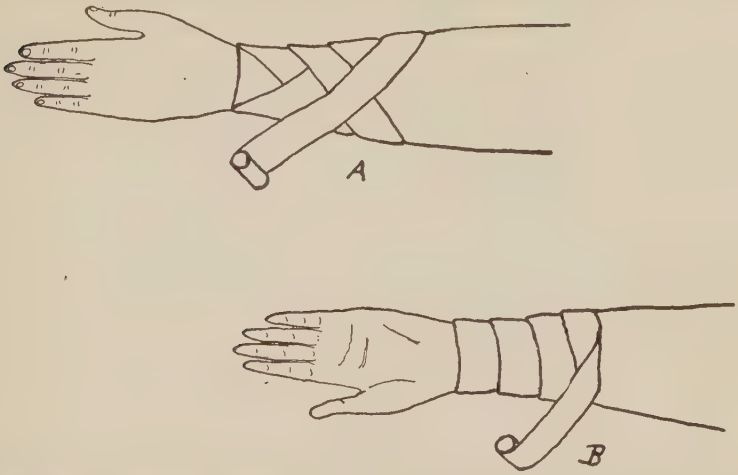


FIG. 148.—REVERSE FIGURE-OF-8 BANDAGE. *A*, front view showing the figure-of-8 turn; *B*, rear view showing the reverse turn.

In this case the cross of the figure-of-8 turn is made on the top of the arm (A of Fig. 148) and the reverse on the back (B of Fig. 148). This bandage is very much preferred to any other by some persons because of its *superior durability*.

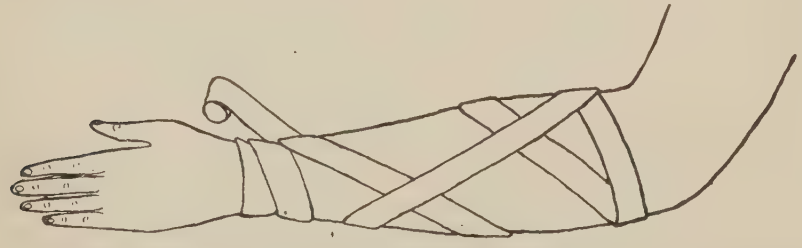


FIG. 149.—METHOD FOR SECURING BETTER ANCHORAGE OF A BANDAGE ON A TAPERING PART. The long spiral turns provide friction for the remainder of the bandage and also stabilize the wrist portion.

Another variation sometimes employed for securing durability in a bandage of a forearm which is extremely conical in shape is to run a *long spiral turn* (just after completing the wrist section) from the wrist to the elbow, one or two circular turns

around the arm just below the elbow, and then the long spiral back again (Fig. 149). This gives the forearm bandage the advantage of a little *more friction* for keeping it in place on the sloping part, as it will not tend to slip so much on these turns of gauze as it would on the bare skin; and these layers have been made very secure by the turns at the elbow.

Foot and Leg

The *toes* may be bandaged separately, like the fingers; and when the figure-of-8 extension is necessary to keep it in place the ball of the foot will usually answer as the wrist does for the fingers. Also, as in the case of the fingers, when several or all of the toes are involved they will usually be dressed together and the bandage will be the recurrent one.

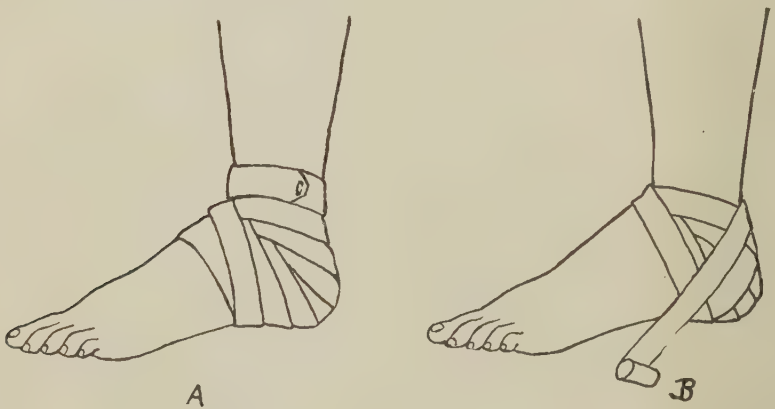


Fig. 150.—Heel Bandage. *A*, regular circular and figure-of-8 method; *B*, variation necessary for a prominent heel—an interlocked figure-of-8.

Under Mode 4, page 428, the ankle bandage has been presented but the heel was not included as it involves one or two special considerations, and in practice it is not covered in a foot bandage unless there is a particular reason for doing so. When *the heel* is involved the principles of the elbow bandage may be applied to it—that is, after the circular turns have been applied around the arch of the foot a long spiral turn of the bandage will carry it smoothly to the heel, a circular bandage is applied around the heel and the instep, and the figure-of-8 ankle bandage is then applied as in the case of the elbow (A of Fig. 150).

In cases where the heel is unusually prominent it will be impossible to cover it smoothly with the figure-of-8 bandage. This

difficulty may be overcome by modifying the design for several turns as illustrated in B of Fig. 150. An analysis of these turns will show that they constitute merely an interlocked figure-of-8 passing crosswise of the ankle.

In general principles the *foot and leg bandage*, as a whole, is exactly like that for the hand and arm. Disregarding the toes, we start around the arch of the foot with the circular

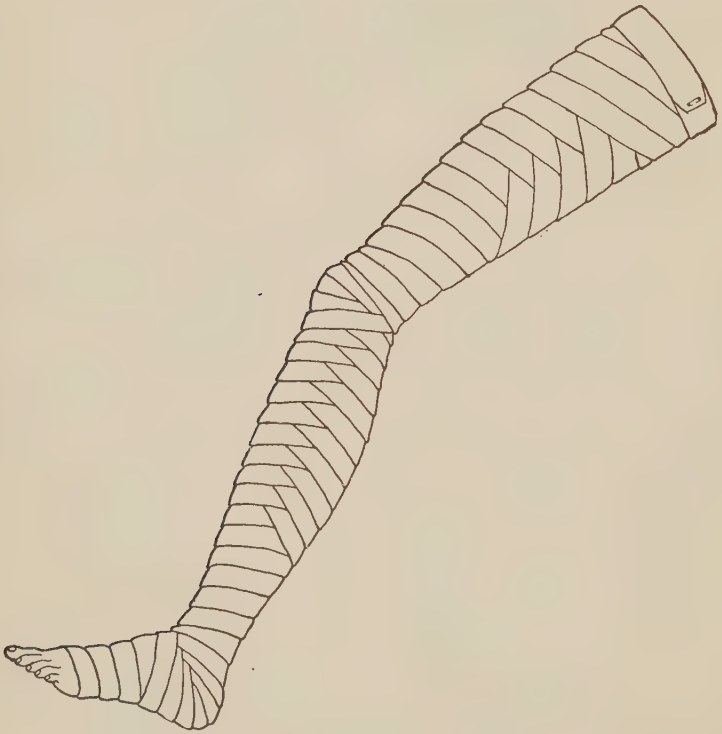


Fig. 151.—Complete Bandage for the Foot and Leg.

turns, and one or two spirals if needed. Then cover the heel as described in the preceding paragraphs. This will entail the figure-of-8 of the ankle which was described under Mode 4, page 428. The details for the remainder of the leg will then correspond exactly with those given for the arm, including the several variations pointed out there (Fig. 151).

The knee-joint bandage, of course, will be upside down from the standpoint of the bandager as compared with the elbow, but this will not cause any noteworthy confusion.

The Eye

The eye bandage becomes a very simple one if we conceive of it as being constructed, as it really is, entirely from the elementary circular bandage. Accordingly, let us imagine our standard circular bandage to be rigid, like a barrel hoop, and fit it thus into the several positions of the layers in the eye bandage. First of all, we place it around the top of the head as we did the circular bandage in the demonstration of Mode

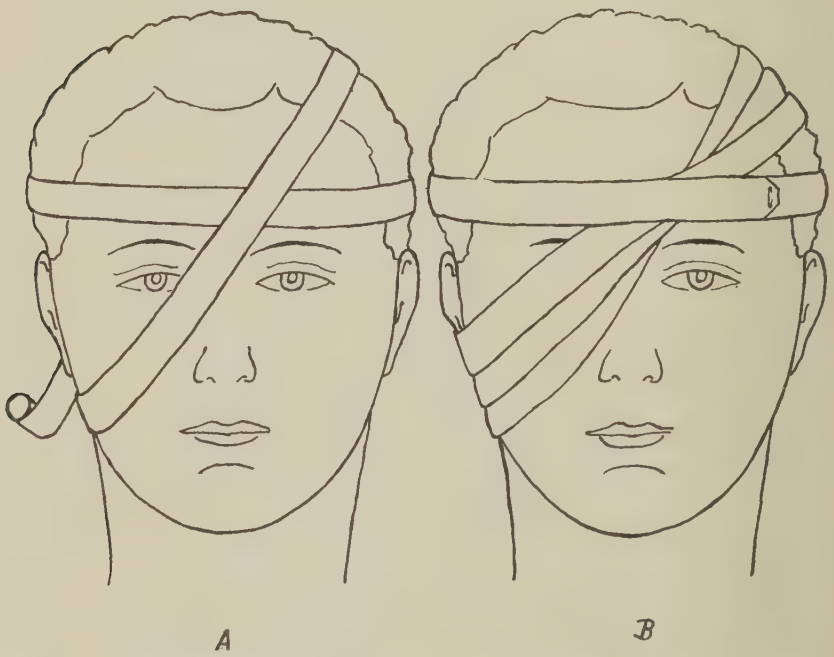


Fig. 152.—The Eye Bandage. *A*, the first two circular turns in place; *B*, the completed bandage for one eye.

No. 1; this is our foundation, or anchorage. Then we imagine this circle on a pivot near the base of the nose and swing it down over the eye we are to bandage till it reaches the neck just below the ear on that side, and meanwhile, on the opposite side just over the other ear, it will have risen somewhat above our foundation circle. The two circles will now cross each other on the forehead and on the back of the head (A of Fig. 152). Then we swing our circle again but only far enough this time to cover

one-half or one-third of the width of the parts of the other layers which lie below the one ear and above the other. In other words, this layer lies the width of the lap nearer each ear than the preceding one and crosses it on the forehead and on the back of the head at the sites of its intersections with the horizontal turn. This maneuver is repeated until we have enough angling layers (usually two or three) to cover the eye well, and then we swing our circle back again into the first position and apply one or two of the horizontal turns to anchor the whole (B of Fig. 152). On some heads it may be necessary to anchor each angling circle with the horizontal one, but this will mean merely swinging the circle alternately from one position to the other.

The flexible bandage will not perform with all the mechanical exactitude of the rigid hoop, of course, and the changes in plane will have to be made with gradual sweeps, but these will be easily managed if the student has her picture of the hoop structure clearly in mind.

To bandage both eyes all one needs to do is to alternate the angling turns between the two eyes, and, as a rule, one anchoring turn should be applied for each pair of angling ones. The whole is, of course, anchored finally with one or two of the horizontal turns (Fig. 153). A gauze or cotton dressing should always be placed over the eye in practicing this bandage.

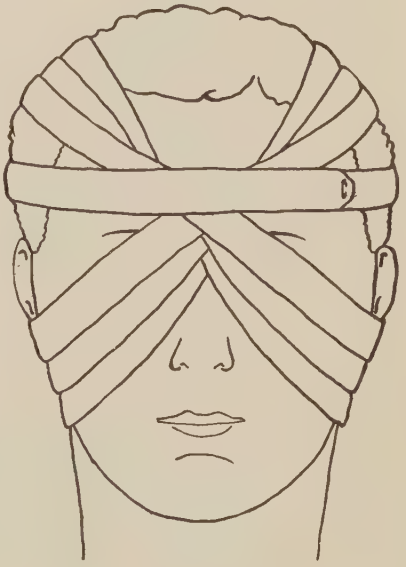


FIG. 153.—DOUBLE EYE BANDAGE.

The Ear

The ear bandage, for either one or both ears, will correspond to that for the eyes in all detail except that more turns will be necessary as a rule (Fig. 154). In bandaging one ear it is sometimes difficult to avoid covering the opposite one also, but by careful planning this difficulty can practically always be over-

come. A gauze or cotton dressing should always be placed behind the ear in practicing this bandage.

The Face and Jaw

The Barton bandage of the jaw will be used in case of fracture where immobilization is desired. When analyzed this may be called a compound figure-of-8 bandage, for it is composed of two figure-of-8's which have one loop in common—that is, the loop which envelops the crown of the head makes a figure-of-8 with either one of the two adjoining ones. To apply this bandage, begin by laying the end of the bandage diagonally across the top of the head, pass downward across one cheek, underneath the chin, upward over the other cheek, across the head in the other diagonal (A of Fig. 155), downward and around the back of the head, forward around the front of the chin, thence to the back of the head, and then upward to the starting point at the top of the head. This is the complete design of the bandage (B of Fig. 155), but as it is usually applied for pressure upon the jaw one or two layers more will be added. This bandage will usually be applied under considerable tension.

Fig. 154.—The Ear Bandage. Note that it is merely the eye bandage design slipped about one-quarter of the way around the head, and that more turns are required for the ear region than were needed for the eye.

The illustrations (Fig. 156) show *two ways of applying a bandage to the cheek, temple, or chin.* They need no special explanation except that they are started like the Barton bandage. Since heads vary so much in shape a trial must always be made of the first turn of these bandages to make sure that it is stably stationed. A variation forward or backward, on the top of the head, of the starting point, will always enable one to find the proper balance.

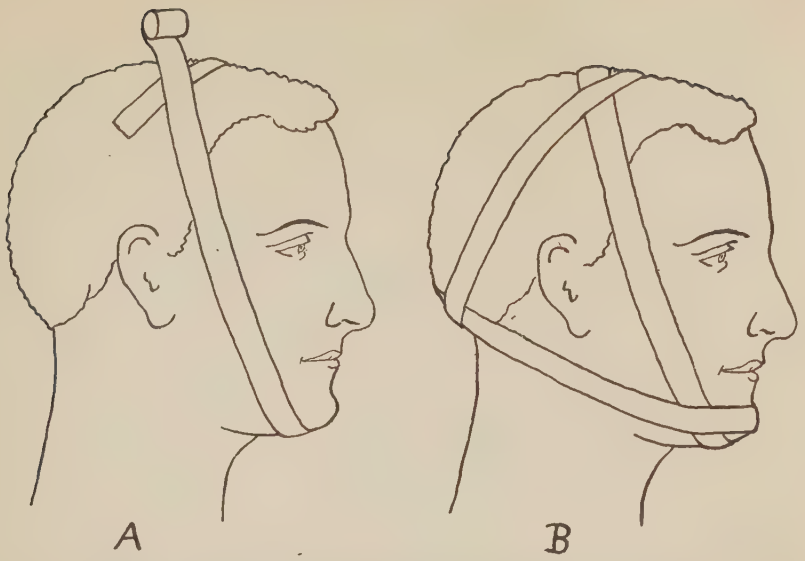


FIG. 155.—THE BARTON BANDAGE. *A*, method of anchoring; *B*, the complete design. As this is usually a pressure bandage two or more layers will usually be necessary. The fastening of this bandage is not shown as it will be best placed on the head or face turn on the other side.

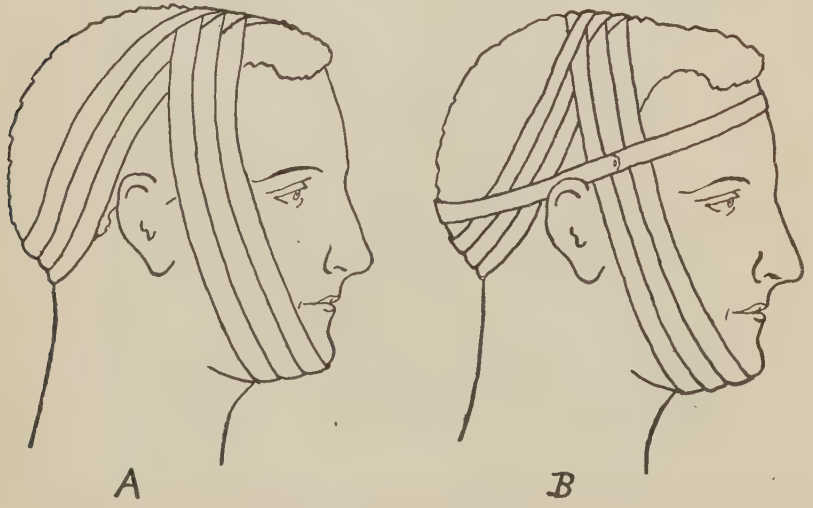


FIG. 156.—TWO METHODS OF BANDAGING THE CHEEK, TEMPLE, OR CHIN. *A*, a simple figure-of-8 which will fit a head with a prominent crown; *B*, method necessary when the crown of the head is flatter, the turns about the forehead alternating with the others and binding them in place. Bandage *A* is fastened on the other side of the head.

The Head

The appropriate bandage for the head is the recurrent one which we described under Mode No. 5 (Figs. 143 and 144, pages 429 and 430).

A more convenient way to apply the head bandage, however, is with *two roller bandages*, the ends of which have been carefully pinned or sewed together (Fig. 157). For this we proceed thus: Lay the bandages against the middle of the forehead, and then hold one stationary while you apply the anchoring circular bandage about the head with the other. Then pass the bandage which

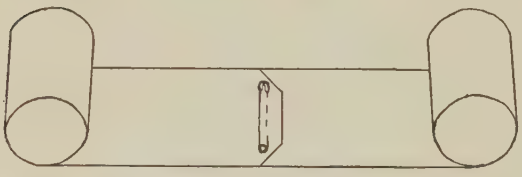


Fig. 157.—Double Roller Bandage for the Application of the Recurrent Bandage.

Fig. 158.—The Way to Use the Double Roller Bandage.

has been idle across the top of the head to the circular turn at the back, roll the other bandage across this (Fig. 158),

and then continue carrying the one bandage back and forth over the top of the head and binding it down at each end by the circular turns of the other.

The whole head may, of course, need to be covered thus, but the student should form the habit (which does not seem natural for beginners) of putting on only as much of the head bandage as is necessary to keep the dressing in place, as it is very easily discontinued at any point.

This recurrent bandage, especially when applied to the head, is usually designated as the *"capeline" bandage*, because of its likeness to an iron skull cap which was worn by soldiers in the Middle Ages.

The Shoulder and Axilla

The "spica" is the bandage most frequently used for the shoulder (Fig. 159). Like the thumb spica, of course, it is merely a figure-of-8 design, and needs no comment except, perhaps, to point out that the application of it is begun about the arm, and that a few spiral or reverse turns should be made around the arm for secure anchorage before beginning the spica proper.

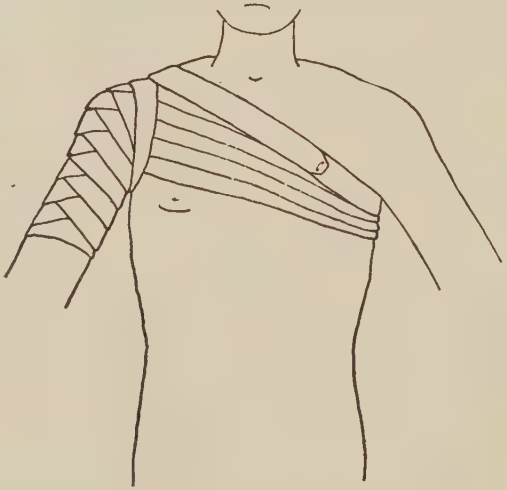


FIG. 159.—THE SPICA BANDAGE OF THE SHOULDER.

When there is a dressing in the axilla to be covered *the shoulder spica may be varied* by alternating turns around the chest with the figure-of-8 turns (Fig. 160).

The Velpeau bandage will be used to immobilize the shoulder in such cases as fracture of the clavicle or scapula or dislocation of the shoulder. Place the arm of the injured side across the chest so that the hand lies well up toward the other shoulder. Start the bandage by placing the end over the scapula of the

sound side, carry the roller forward over the injured shoulder, angling downward and underneath the humerus, and thence forward over the anterior chest and around to the starting point (A of Fig. 161). Repeat this turn once for security and strength, then make a circular turn around the chest and over the arm just at the elbow, and then complete the bandage by alternating these two turns till the whole arm has been covered (B of Fig. 161). Non-absorbent cotton should be arranged comfortably under the patient's hand and arm before this bandage is applied.

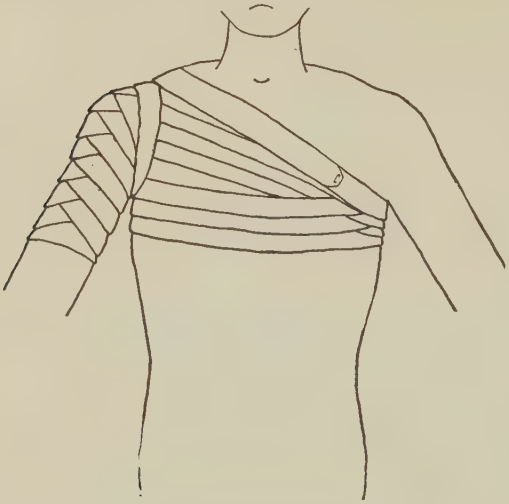


FIG. 160.—THE SHOULDER SPICA BANDAGE VARIED TO COVER THE AXILLARY REGION.

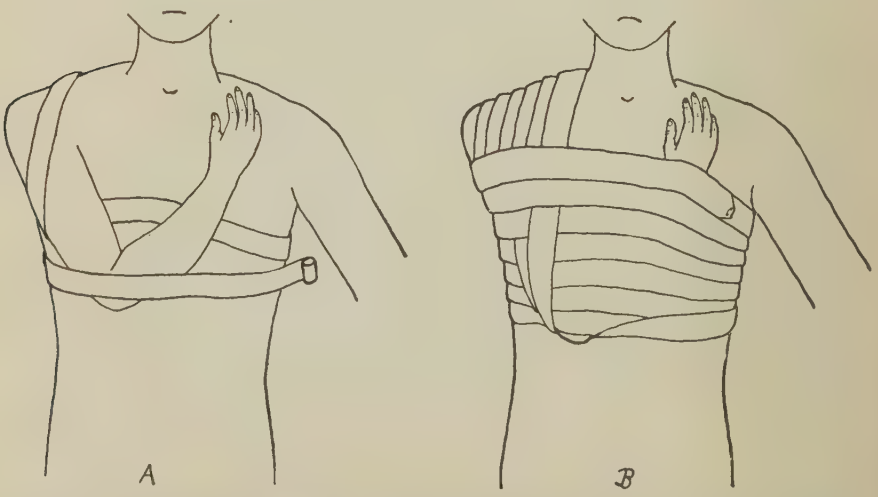


FIG. 161.—THE VELPEAU BANDAGE. *A*, the first turns, two or more layers being necessary, as a rule, in the turn about the humerus; *B*, the completed Velpeau.

The Breast

This bandage is another figure-of-8, one loop of the figure passing horizontally about the chest and the other diagonally between the affected side and the opposite shoulder (A of Fig. 162).

Start underneath the arm of the affected side and anchor the bandage with two circular turns about the chest just beneath the breast, passing the roller across the anterior chest first and then around the back—that is, when the right breast is to be bandaged the end of the bandage is placed under the right arm and the roller is carried across the anterior chest to the left

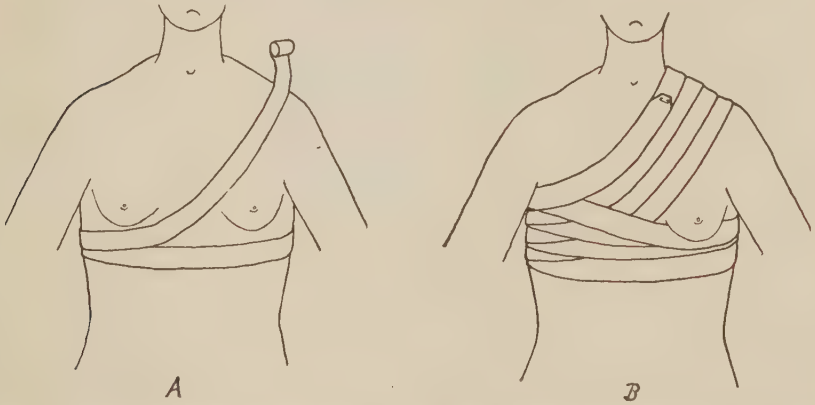


Fig. 162.—The Breast Bandage. *A*, the way to start the bandage; *B*, the complete design.

arm; and for the left breast the direction is reversed. The anchorage completed, the first diagonal turn is started directly underneath the breast, and is carried well over on the opposite shoulder, thence angling downward across the back and around to the starting point. These alternate horizontal and diagonal turns are then repeated till the whole breast is covered (B of Fig. 162).

To bandage *both breasts* at the same time, start as for one. Apply the first diagonal turn, start the next horizontal turn but carry it only as far as the opposite side and then instead of completing it carry it diagonally upward across the back to the other shoulder, and thence diagonally downward across the anterior chest and underneath the other breast. Then apply a

complete circular turn and extend it around to the starting point under the first breast. Continue the bandage by alternating the diagonal maneuvers with the horizontal one till the breasts are covered (Fig. 163).

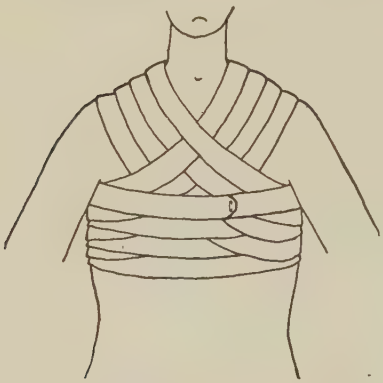


FIG. 163.—THE DOUBLE BREAST BANDAGE.

Hip Spica

There is no essential difference between this bandage and the spica of the thumb. The hip spica is sometimes applied without the circular turns about the waist (A of Fig. 164), but the alternation of the circular turn with each figure-of-8 (B of Fig. 164) makes a more durable bandage and one which will be more comfortable for most patients. Any part of the hip region may be covered with this

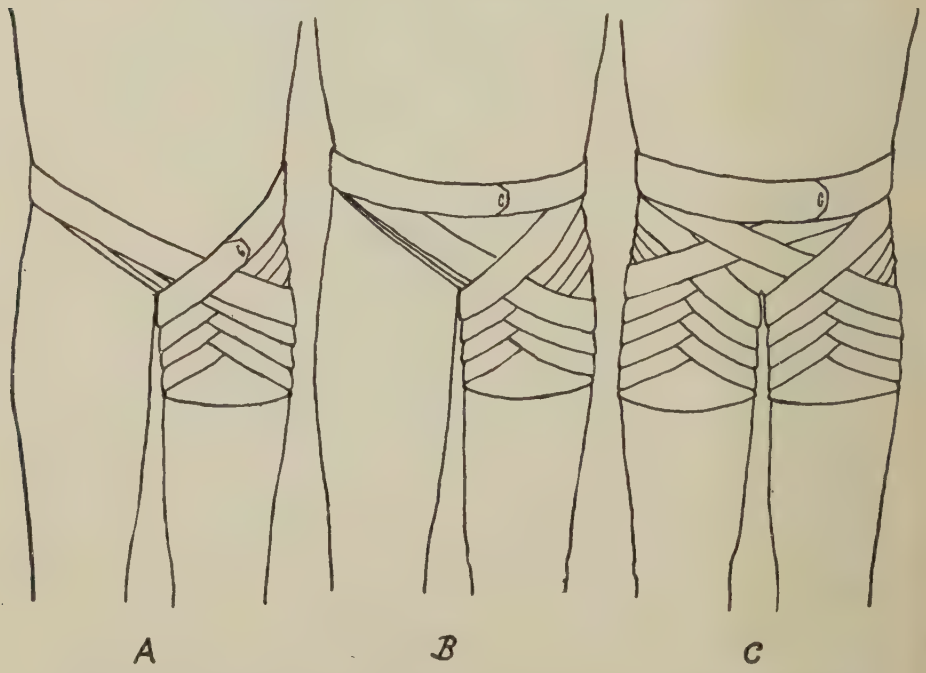


FIG. 164.—THE HIP SPICA BANDAGE. *A*, without the circular turn about the waist; *B*, with the circular turn alternating with each figure-of-8; *C*, the double spica applied with a single bandage.

bandage by simply placing the spica directly over the wound. This bandage may be started around either the waist or the leg.

A double hip spica is very readily applied with one bandage by simply alternating the figure-of-8's between the sides and inserting circular turns about the waist between them each time (C of Fig. 164). This bandage may be started around either the waist or one leg.

For the application of these bandages it will be necessary to elevate the patient's hips on some such rest as that shown in B of Fig. 59, page 265.

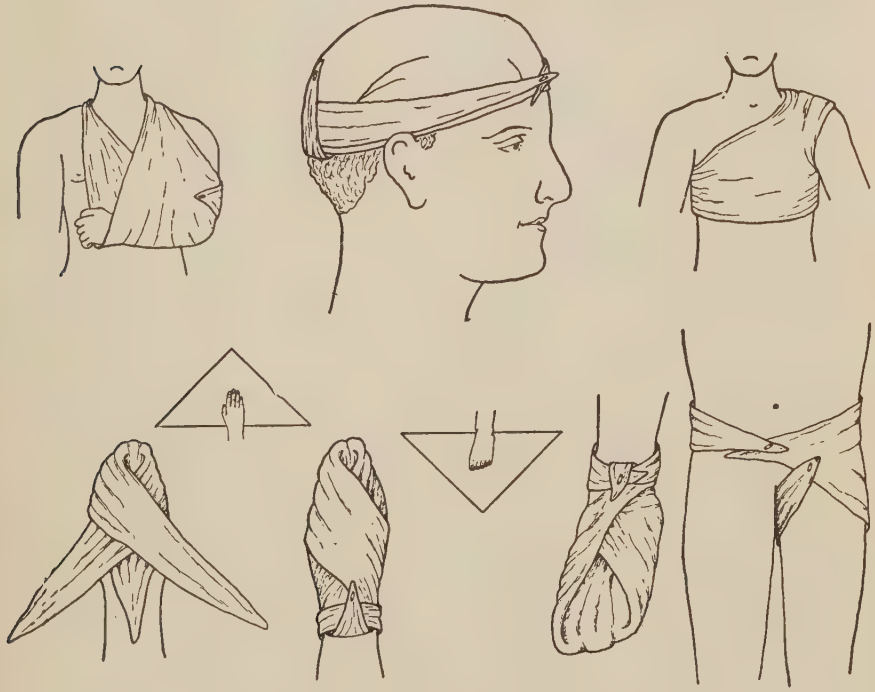


Fig. 165.—Various Applications of the Triangular Bandage.

(b) *The Triangular Bandage*

As remarked previously, the triangular form of bandage, with one or two exceptions (chiefly the sling), is an emergency one and will be used only in the absence of the roller bandage. Emergencies, however, are very important and the nurse should, therefore, not consider her bandaging education complete till she

has become adept with the triangular bandage. Parts to which this bandage may be applied are the arm (sling), hand, head, foot, shoulder, hip, etc., and the illustrations (Fig. 165) will give the student all the suggestions she will need for the several cases.

The three principles of bandaging are, of course, as applicable to this form of bandage as to the roller one.

(c) *The Many-Tailed Bandages*

The student's first concern as to these bandages is to make them of the proper size because they must fit well if they are

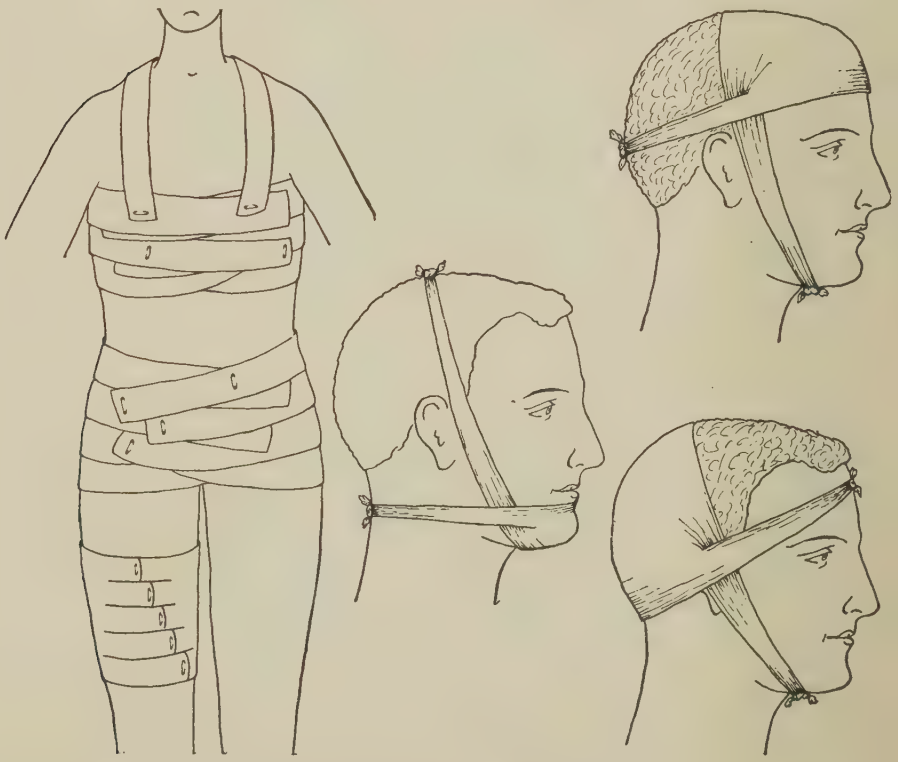


Fig. 166.—Various Applications of the Many-tailed Bandages.

to be faithful to our three bandaging principles. Parts to which the several types are applicable are the head, chin, breast, abdomen, arm, leg, etc., and the illustrations (Fig. 166) will show the variations suitable to these different parts.

MISCELLANEOUS SPECIAL BANDAGES

The *plaster of Paris bandage* is a roller bandage, but as it is applied wet and eventually becomes very rigid, its application involves a few points which differentiate it from the average roller bandage. First of all, the plaster is never placed directly upon the skin, a substantial padding of cotton, Canton flannel, or stockinet, etc., always being used underneath it. The nurse will rarely ever apply this bandage herself but she will assist with it and her part will doubtless be the soaking of it. This she will do by standing it on end in a basin of sufficient warm water or weak salt solution to cover it. A very few moments will suffice for saturating it, the cessation of the bubbling which always follows immersion indicating that it is ready for use. Since you have probably made the bandage yourself you will know how insecure the plaster is within it and will therefore be very cautious about the removal of it from the water. It must be squeezed just enough so that the water will no longer drip from it—no more and no less—for if too wet the dripping water will carry the plaster away with it and will unnecessarily wet the padding, and if too dry it will become hard before it can be applied. Your method, therefore, will be to encircle the bandage very cautiously with a hand at either end, compress the ends gently at the same time, lift it out of the water, and simultaneously extend your pressure over the remaining surface just sufficiently to stop the dripping—but do not twist it. Practice is required to do this well and without wastage of the bandages, for it must be done quickly as well as carefully. As light wood splints are sometimes used to reinforce this bandage they will be part of the nurse's preparation, as will also a small amount of dry plaster which is sometimes used for finishing the surface of it.

For the application of *the starch bandage* the nurse's preparation will be similar to that for the plaster, but the bandages will not require the extreme care in handling and they may be more nearly freed of the water.

The *Esmarch bandage* is sometimes applied for the purpose of reducing the venous circulation of a congested part and thereby increasing its arterial supply and the accompanying local nourishment. This constitutes a special treatment known as the "Bier's" treatment. It will, therefore, never be administered except by

special order, but it belongs to the subject of bandaging and there are several points about it which the nurse should learn.

The treatment is usually administered to some inflamed part of the extremities, and the general rule of applying the bandage from below upward will hold in this case. The mode of application will be the spiral one; the bandage will be applied above the inflamed part; and as the object of the bandage will be to restrict the venous circulation and not the arterial, it must not be applied too tightly. The frequency and duration of this treatment will be prescribed, and while it is in operation the nursing attention must be faithful. The parts below the bandage should retain their normal temperature; there should be no accompanying pain; the pulse in the part should not be altered; but a moderate amount of swelling and edema, and a bluish-red color, should be expected. As a rule, the part will be elevated after the bandage has been removed to hasten the reduction of the edema, but the nurse will be guided by instructions from the surgeon as to this. The Esmarch bandage will be used occasionally in the operating room to empty the vessels of a leg or arm so that there will be no bleeding during the operation. The nurse will rarely apply it in this case, and if it should be her duty she will be directed for the particular case by the surgeon; but in general the extremity is elevated for a few moments to reduce the amount of blood in it as much as is possible by this means, and the bandage is then applied spirally from the fingers or toes upward very tightly to a point beyond the operative field where it is securely fastened. The part overlying the operative field is then stripped off and the remainder left in place during the operation.

Varicose veins of the leg are sometimes treated with a *pressure bandage.* The material to be used for this bandage will usually be prescribed, and it may be any one of those we have already discussed. The elastic materials, however, will probably be given preference, though where elasticity is desired it may be secured in some degree with an inelastic bandage by first covering the part with a thin layer of non-absorbent cotton. The importance of this bandage from our present standpoint lies in the requirements that it be very smoothly and evenly applied, that its tension be sufficient to support the enlarged veins without obliterating them, and that it be applied as follows: Elevate

the foot somewhat before applying the bandage so that the veins will not be unnecessarily engorged; start the bandage near the toes; and use the spiral form as much as possible throughout, departing from it only sufficiently to secure even pressure over the more irregularly-shaped parts.

A pressure bandage is sometimes applied to the extremities, particularly the legs, in case of shock to reduce the circulation in them to some degree and thereby to conserve the heart's energy somewhat. A generous layer of non-absorbent cotton should always be used under this bandage because, while it furnishes the usually desired elasticity it also conserves the body heat which is vitally important in such cases.

Many of the bandages described in the practical discussion above might properly be classified here also as "special" bandages—for examples, the ankle bandage in a case of sprain, the Velpeau, the Barton, some of the spicas, and sometimes the breast bandage—but as they are thus distinguished merely by their greater tension they merit only mention in this connection.

THE FASTENING OF THE BANDAGE

(a) *The Roller Bandage*

First of all, *the site selected* for the securing of the end of the bandage should be remote enough from the wound to avoid causing pain to the patient by the manipulation necessary. If not inconsistent with this point, an accessible place should be chosen for evident reasons. And of not the least importance is the point that all fastenings that protrude, such as knots and safety pins, should be so placed that the patient will not have the discomfort of resting upon them.

There are only about *four good methods* for fastening the bandage and they have their special adaptations and limitations as follows:

1. **Safety Pin.**—This fastener (A of Fig. 167) will apply to most bandages and it is a very satisfactory one because it can be passed through all the underlying layers and so bind them all securely together. It may sometimes be objectionable, however, for children in places where they can reach it and open it, or where they might injure themselves upon it. Likewise, irrational patients are liable to interfere with this fastener.

2. **Adhesive Plaster.**—This is an unobtrusive and neat

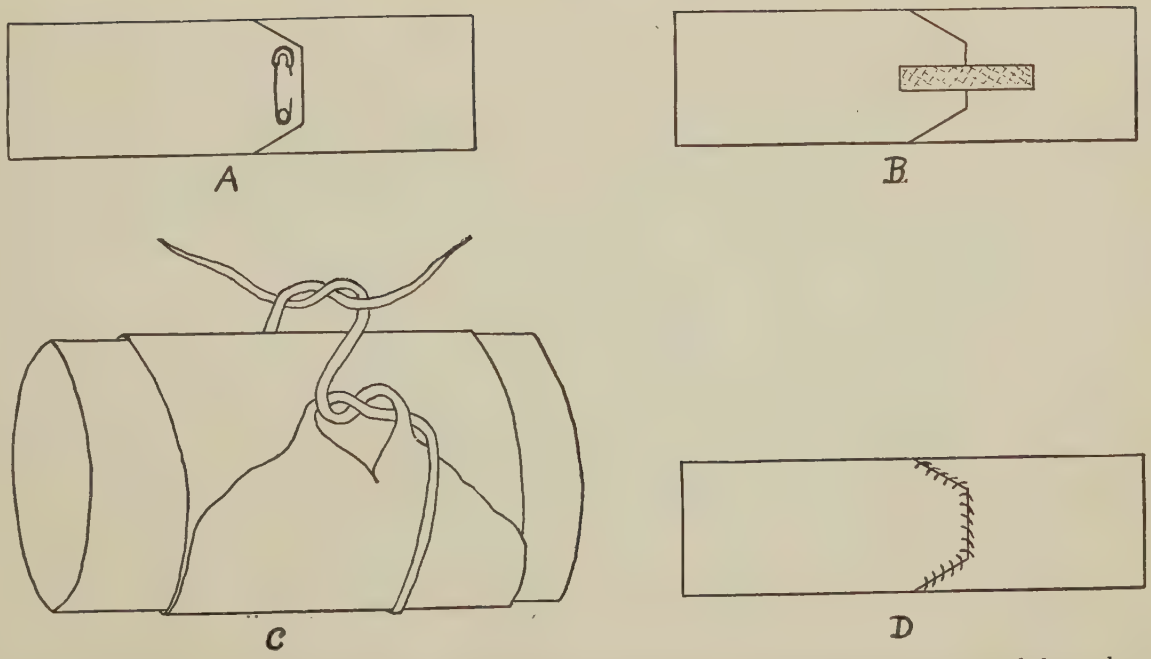


FIG. 167.—METHODS OF FASTENING THE ROLLER BANDAGE. *A*, the corners of the end have been turned under so as to make a stronger and neater finish, and a safety pin has been passed through it and as many of the underlying layers as possible; *B*, the corners of the end have been neatly turned under and a strip of adhesive plaster binds it to the layer underneath; *C*, the end of the bandage has been split lengthwise far enough to make two tails long enough to be tied around the part, a knot being tied at the bottom of the slit to prevent further tearing; *D*, the corners of the end are turned under and a few stitches of thread taken between it and the immediately underlying layer.

fastener (B of Fig. 167) but it is not as secure as the safety pin and will not, therefore, answer for some pressure bandages. Also, it cannot be used for a bandage over a wet dressing nor in any other case where the bandage is likely to become wet, as in the instance of the Carrel-Dakin treatment.

3. **Tying.**—This is a rough-and-ready method (C of Fig. 167) which can always be resorted to in the absence of other means. To fasten the bandage by this method, tear or cut it down the middle of the end, tie a knot at the bottom of the slit to prevent further tearing, and then tie these strips around the part. The student should learn this method but she should immediately store it away for emergency use only, as it is almost never comfortable to the patient because of the fact that if it is tight enough to hold the bandage in place it will cause a line of stricture.

The Esmarch bandage is an exception to this case in that tying is about the only suitable method for it. The rubber will not, of course, be split to make the strings, for tapes are usually cemented to one end for the purpose. If these are lacking, however, a few turns of a gauze bandage, a piece of tape, or anything similar may be fastened about the terminus of the Esmarch. The above-mentioned objection to tying does not enter into this case because the rubber is rigid enough to dissipate the objectionable pressure of the string.

4. **Sewing.**—This method (D of Fig. 167) is applicable where greater strength is needed, or in the case of children or irrational patients. It goes without saying, of course, that great caution is necessary in sewing a bandage on a patient.

(b) *The Triangular Bandage*

The safety pin, tying of the corners, or both (see Fig. 165, page 445), will cover all cases for this bandage.

(c) *The Many-Tailed Bandages*

Tying of the ends or safety pins will answer for the head and chin bandages, but for the other parts safety pins are all but indispensable (see Fig. 166, page 446).

MISCELLANEOUS BANDAGING RULES

1. *Never bandage two surfaces of skin together*—separate them with gauze or cotton, preferably non-absorbent cotton. There is always a certain amount of moisture present on the surface of the skin and if this is confined it will accumulate, and in addition to being uncomfortable it may seriously chafe the parts in time. The non-absorbent cotton keeps these surfaces apart and allows evaporation of the moisture, whereas absorbent cotton or gauze absorbs and retains it. This applies particularly to the fingers, toes, axilla, and the arm and chest in the case of the Velpeau bandage.

2. In all cases where surgical necessity does not contravene, *parts should be bandaged in their accustomed position.* This applies with special emphasis to the ears, which should always have sufficient padding behind them to prevent their being held more closely to the head than is natural for them. Bandages of the neck, axilla, the hand and fingers, and the toes, also call for special consideration in this respect.

3. In bandaging the hand and foot *leave the fingers and toes exposed* if possible so that they may be watched as guides to the condition of the circulation of the limb. Coldness, blueness, and swelling of the fingers or toes, or of any part below a bandage, are signs that it is too tight at some point. This accident is very largely precluded by attention to pressure in the application of the bandage, but it must not be forgotten that parts under even the most expertly applied bandage may swell later from causes entirely unrelated to the bandage itself. In the cases of the arm or leg the pulse, if accessible, at the radius or the dorsum of the foot will, of course, be a valuable guide to the state of the arterial circulation.

4. *Do not apply a wet bandage* because it will probably shrink in drying and become too tight. The plaster of Paris and starch bandages are, of course, exceptions, but they are always applied with this in mind, and a thick padding of stockinet, cotton, or Canton flannel is usually provided underneath them to guard against this danger.

5. When applying a *bandage over a wet dressing*, or over a Carrel-Dakin dressing, which will eventually become wet, remember this probability of shrinkage and apply it correspondingly *loosely.*

6. If necessary to *bandage a dressing under a splint*, remember to do it *loosely* because, even though you may be able to note the condition of the part, it will be very inconvenient to correct undue tightness in this case, and durability is not important here since the splint and its bandage will give the additional security needed.

7. In *placing the reverses* of the reverse bandage, see that they are not over bony or prominent parts, such as the tibia or radius, for they may become very painful because of the uneven surface they create. The line of these reverses is best placed on the outside of the leg and arm.

8. Always *apply the roller bandage from below upward*, particularly when exerting special pressure, because when put on in the opposite direction, it allows the veins, which are eventually to be underneath it, to become engorged with blood which is thus imprisoned and may later be the cause of much discomfort and even more far-reaching trouble. Likewise, the Scultetus bandage should be fastened from below upward.

9. Make it a rule in applying the roller bandage to the extremities to *start by rolling it outward* rather than inward—that is, to bandage a right arm or leg (assuming that you are face-to-face with your patient), hold the roller in your left hand and start by rolling it toward your left side; to bandage a left arm or leg, then, you will hold the bandage in your right hand and start it toward your right. A test application will show you that observance of this rule will give you greater freedom and ease in the adjustment of the reverses and the figure-of-8's.

THE REMOVAL OF ROLLER BANDAGES

Gauze and paper bandages are rarely ever used more than once and they are therefore usually cut away. If one is equipped with the special bandage scissors (B of Fig. 168), the operation is very simple as the blunt point can be passed underneath the bandage with perfect safety, provided, of course, that the region of the wound is entirely avoided, as it should be in any case.

The *washable and rubber bandages* will simply be unwound, and a little practice will enable one to roll them together loosely as fast as they are unwound. Dexterity in this is really a

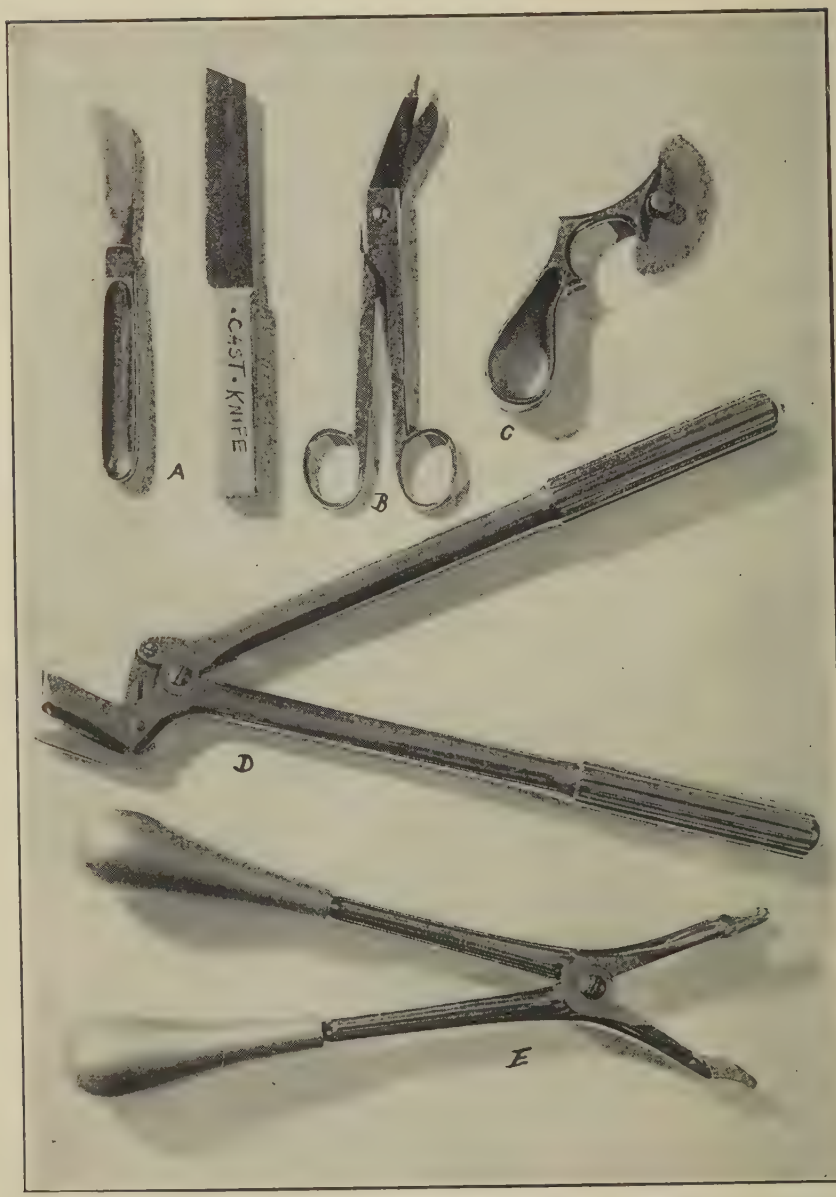


FIG. 168.—PLASTER CAST INSTRUMENTS. *A*, two types of cast knife; *B*, heavy bandage scissors; *C*, cast saw; *D*, cast shears; *E*, cast-spreading forceps.

valuable acquisition because it saves much time and avoids annoyance to the patient and confusion to the bandager.

For the removal of *plaster of Paris bandages* one needs a strong knife or saw and a pair of strong bandage scissors. There are special instruments (Fig. 168) made for this purpose and they will usually be provided in hospitals. The operation consists merely in cutting directly through the entire length of the shell in a sufficient number of places to enable one to lift the cast away with as little disturbance as possible to the patient. The lines chosen must be accessible, of course; if possible they should be remote from the wound (if there is one); and to save labor one should select the shortest lines that will answer the purpose. Some labor may be saved in the sawing process by wetting the plaster immediately ahead of the instrument with a few drops of hydrogen peroxide, acetic acid, or bichloride solution. These solutions have a slightly solvent power over the plaster, but a little plain water answers the purpose very well also. Care should be taken not to use enough of these solutions to wet bandages or dressings underneath, and it should also be remembered that the bichloride will be very unkind to the metal instruments if exposed to them too long. The precaution should always be taken of discarding the knife or saw in favor of the scissors before this bandage is entirely severed, to escape the danger of cutting the patient. Sometimes this labor will be obviated by the surgeon who will cut the plaster just after applying it and while it is still soft. In this case the cast will be bound together by a strong bandage and its removal will then be a simple matter.

Starch bandages can usually be cut with strong bandage scissors, though if they are thick the plaster knife or saw may be needed.

Finally, practice is the only means of learning how to apply a bandage so that it will stay on and appear well; and wearing one is the best means of acquiring a sympathetic appreciation of the importance of applying it evenly and at a comfortable tension. It is a good plan for a class of students to use one another as subjects, because in this way they get the viewpoint of both the bandager and the bandaged, and the good bandager is the one who compromises the two factions in the case.

CHAPTER XXII

OPERATIONS IN THE HOME

THERE is perhaps no greater bugbear to the young nurse than the prospect of having to prepare for an operation in the home. No matter how excellent her course of training may have been in general, she very rarely has learned the solutions of the many practical problems which will arise when she is out of reach of the elaborate equipment and the ready-to-use supplies which made life comparatively simple for her in the hospital operating room. However, the nurse who has learned her hospital lessons best will, of course, succeed best in the home because operations in the home, while they do not call for new principles, they do call with a vengeance for special combinations and adaptations of the old ones. This is really a hard task until one has had a little experience, and even with experience, each home will make some new demand upon one's ingenuity and technical elasticity. System and good technic are easy in the hospital operating room where practice has standardized everything in such a way as to make them almost automatic, but in the home natural conditions are often quite adverse. One can always succeed, however, by virtue of the very fact which often hinders system in the hospital, namely, that there are so many roadways to Rome.

We shall now assume that you have had a good course of training in the hospital operating room, that you have studied Chapters XV to XVIII thoroughly, and that you have in mind clearly the things you will need and your general course of action, and with this for your armament we shall take you into the home and endeavor to guide you there in the preparation for an operation.

If you have been nursing the patient a day or so before the operation you may have had some warning and will, therefore, have the advantage of doing some preliminary preparation leisurely. If you are called on short notice, however, you must

know how to make the most of your time, because shortness of time is not always a good excuse for poor work. In general, then, we shall say that when you are called to prepare for an operation in the home you should proceed in this order:

First Step.—*See to the supply of sterile gauze dressings, towels, sheets, caps, gowns, masks, and gloves.* Often the surgeon will have these in readiness in his office and you will not need to supply them. In other cases you may be so situated that you can buy everything you will need from some supply house. But often you will need to collect the best supply you can find about the house or elsewhere and sterilize it by any means you can devise.

There is scarcely any substitute for gauze in an operation, but either it or its first cousin, cheesecloth, will be available in the most remote place. How you make up your dressings will depend chiefly upon the time you have, but be as simple as possible. If the operation is to be an abdominal one you should provide. if you can, something to answer the purpose of the *abdominal tail pads* described on page 271. The other gauze supplies, besides the wipes and wound dressings, will depend entirely upon the case.

Gowns will not be found in the home, and if the surgeon does not supply them you will need to substitute something else. About the only thing you can use is a large *muslin sheet*, and this can be made to work very well indeed by draping it about the body in some such fashion as that illustrated in Fig. 169.

Improvisation of the cap will be very simple for any nurse with a piece of muslin or gauze (Fig. 169).

Likewise, *the face mask can be very quickly made* from gauze or muslin (see mask C, Fig. 63, page 270).

Sheets and towels must be what you can get, but always use the muslin ones rather than the linen if you have a choice, as they are more satisfactory in every respect.

It will rarely ever be advisable to undertake to provide a supply of dry sterile *gloves* because there will be no suitable home method of sterilizing them thus, and their preparation will be suggested later on.

Perhaps the best type of improvised *sterilizer* is made from a wash boiler which has a well-fitting lid. Fill the boiler about one-fourth (or less) full of water. Suspend the parcels to be

sterilized over the water, and just clear of its surface, by one of the following methods: (*a*) Fasten a piece of muslin across, hammock fashion, by tying the ends to the handles of the boiler; (*b*) Make a platform by laying narrow strips of wood upon pillars of bricks, stones, or some similar heavy household article laid in the bottom of the

FIG. 169.—IMPROVISED CAP AND GOWN. For the cap a piece of gauze about one yard long and a half yard wide has been used. Muslin or any similar material will do as well. The gown consists simply of an ordinary bed sheet, one edge of it being laid across the chest, the two upper corners crossed in the back, brought up over the shoulders, and pinned to the edge in front.

boiler anything you can find which will hold the supplies to be sterilized above the surface of the water in such a way as to allow free circulation of the steam through them, particularly from the bottom upward—a kitchen colander, sieve, or a wire dish-draining tray may be well adapted to this purpose. *Cover the boiler* tightly. After the water has reached the boiling

point the heat supply should be so regulated as to keep it barely boiling because the steam is all you need for your purpose and you gain nothing by the vigorous boiling except unnecessary splashing of the water over the supplies. If the cover fits well the weight of it will compress the steam slightly and thereby raise its temperature somewhat. Do not make the mistake, however, of trying to secure the lid of an ordinary wash boiler sufficiently to make it steam tight, as this may result very disastrously.

Continue the steaming for at least one hour.

The parcels must then be dried, of course, and this may be done in the kitchen oven, on the radiator, in the sunshine, or if there is a little time to spare, an electric fan will answer. Care must be taken when using the kitchen oven not to have it so hot that it will scorch the supplies.

The baking oven also furnishes another means of sterilization. If one has a thermometer, the oven can be made to serve quite satisfactorily, as the gauze and muslin materials are safe from scorching below 300° F. and a much lower temperature than that will not sterilize unless maintained for an impracticably long time. However, in the absence of a thermometer one can regulate the temperature fairly accurately around the scorching point by testing it with a loose piece of gauze or muslin or a piece of newspaper and regulating the supply of heat so as to keep the temperature just below this point. This is a rather unrefined method but it is better than none. As the parts of the supplies which come in contact with the metal of the oven will burn sooner than the free parts, it is advisable to put several layers of newspaper under the parcels, as this will serve as an insulator and will also show when the oven is too hot before the damage spreads to the supplies. When there is a shelf in the oven it is better to use this than the floor of it because the shelf will allow better distribution of the heat.

An hour should be allowed for this method of sterilization also.

Parcels to be sterilized by such improvised methods must not be made too large nor too compact because the lack of pressure and exact regulation of temperature make thorough penetration rather uncertain.

In a very rare case you may be so isolated from supplies and

so short of time that you cannot apply any of the above methods of sterilization. In such an emergency it would, of course, be possible to get along by *boiling towels and sheets*, and even dressings, and using them wet, but such an exigency is so improbable as scarcely to be worthy of mention.

Second Step.—*Select the most suitable room.* First, determine the transportability of the patient, and if there is no limitation on that ground you may proceed thus: If the operation is to be done in the daytime *the best lighted* room possible is the one to choose. If it is done at night, or if there is not good daylight available, consideration must be given to the artificial light equipment before the room is decided upon.

If it is large enough and has the necessary light, *the bathroom* is perhaps the best one because it can be most easily cleansed both before and after the operation. *The kitchen* is perhaps the last choice because it will disturb the household routine more than that of any other, and the sanitary objections from the standpoint of both the kitchen and the operation are very strong. Of the remaining rooms the choice will depend, first of all, upon the light, and secondly upon the amount of work and confusion necessary to adapt them for the purpose.

Cases in which you are obliged to use an otherwise undesirable room because the patient cannot be moved will be rare, and you will have to make the best of the situation; but, after all, lack of light would be about the only serious obstacle which would ever arise in such a case.

When the patient's bedroom itself must be used the preparation must be made as brief and simple as possible because it will be an exceptional patient who will not be considerably unnerved by having his misfortune thus emphasized for him. Screens will, of course, help in most cases to shield the patient somewhat, but all rearrangement of the room which is not absolutely necessary should be avoided, and everything possible of a surgical appearance should be kept outside till the anesthesia has been started.

Third Step.—*Renovate the room selected.* This step can be overdone as well as underdone. The room must, of course, be thoroughly clean, but if little time is to intervene between the renovation and the operation the removal of carpets, pictures, etc., will do more harm than good by raising dust which will

not have time to settle sufficiently. When there is a day's warning, for instance, we should remove the carpet in the interest of both itself and the operation, but it is doubtful that it is ever necessary to go to the extreme of removing wall hangings because these articles can usually be made as sanitary as the walls themselves by careful moist dusting. Also, the removal of furniture can be carried to an extreme, because such articles as tables, dressers, etc., can be reasonably cleaned and used as convenient pieces of operating room furniture. One must use a great deal of common sense in adapting a room for operations, and in doing so the time provided will take first place in making decisions, confusion of the household second place, and technical convenience last place. By technical convenience we do not mean technical safety, because safety can be secured under almost any conditions by skilled management after the stage is set.

When carpets are left in place they must be carefully covered both for their own protection and for the confinement in them of any dust which might otherwise be raised. This is easily done by spreading several layers of newspaper upon them, and if the lower layer is moistened with water we may feel that the room is very well insulated from the dust of the carpet. Sheets may be tacked down over the newspapers if desired, but the newspapers themselves probably make a better floor surface for the purpose than the sheets. A large rubber sheet immediately under the operating table is, of course, ideal, but unless it is known that there will be considerable drainage from the wound an extra amount of newspaper will serve as well. The practice of covering pictures, furniture, etc., with sheets is a doubtful precaution because such articles can nearly always be made as free from objectionable features as the sheets themselves by judicious dusting.

Windows which offer a view to the neighborhood may be very easily "frosted" by rubbing a little wet "bon ami" or a thick lather of soap over them. Sapolio and other scouring powders will answer but nothing is so easily applied and removed as the "bon ami."

Fourth Step.—*Boil some water and set it aside to cool for the cold sterile water you may need.* This can be done in any large vessel you can find, and the quantity will have to be

judged from the nature of the operation and the amount your method of hand sterilization will call for.

If you have not been able to secure sterile salt in any other form, it will be wise at this time to provide a pint or more of *10 per cent. salt solution.* This can be made in a small basin or kitchen pitcher from tap water and table salt, and boiled.

Fifth Step.—*Provide the necessary tables, etc.* Some surgeons will bring with them a portable folding *operating table*, but in the absence of this convenience you will need to look about the home for a good substitute. In doing this it must be kept in mind that this table must not be too wide. A long, narrow kitchen or library table will often be suitable; two shorter tables may be placed end-to-end; a strong ironing table may answer very well, with the addition of a small stand at the foot if it is not long enough; a narrow door may be taken down and supported upon small tables, boxes, etc., or extension boards from a dining room table, or any other boards, may be utilized similarly. The height of any of these tables can be increased if necessary with magazines, books, etc. A pad of blankets or something similar must, of course, be provided for the table.

A small stand that may be drawn up to the operating table will be suitable for the instruments, and any other table, dresser top, etc., which can be draped sterilely will answer for the reserve sterile supplies.

If a folding ironing board is available it can be made to serve admirably as an *instrument table* which may be drawn across the operating table.

For the anesthetist's seat a small, low stand may answer, books or a box may be placed upon a chair, or any one of a dozen substitutes may be devised.

Make sure that there will be the proper kind of light. There will usually be an extension light of some kind in the home which may be appropriated if the ordinary light of the room is not sufficient or is inconveniently located.

Sixth Step.—*Collect those other things which will need to be sterilized, such as solution basins, pitcher, irrigator, hand brushes, etc.* Recall the articles we have listed in Chapter XV on page 257, decide upon which you will need, and then select the best substitute available. Hand basins and the other smaller basins can usually be found among the kitchen equipment; a pitcher

will always be at hand; a rubber douche bag, or a kitchen funnel and rubber tube will take the place of the irrigating can for irrigations, infusions, etc.; and hand brushes may be found in every household.

The simplest way to sterilize these things is to *boil them* in the wash boiler or some large kettle on the kitchen stove. If you cannot find anything large enough in which to do this you may have to boil the larger basins directly on the stove with the smaller things inside of them. Basins sterilized in this way will be sterile on the outside as well as the inside, but after standing over a gas flame or a stove of any kind it must be remembered that they will not be clean enough on the outside to associate with the other supplies, and must be kept away from them. Sometimes you may need to resort to the method of sterilizing the interiors of some of these things by means of the *alcohol flame* as described in Chapter XVI on page 289, or one of the chemical solutions may have to serve. With careful management the unsterile outsides of these articles will not do any harm.

In sterilizing these household articles great consideration must be accorded them, and nothing should be used in any way that may be injurious to it unless the family is willing to have it sacrificed. As a rule the family will place anything in the house at your service at this time, but you have so much latitude in the way of substitutes that you need not make any inroads upon family valuables.

At this time boil another teakettleful of water and keep it hot for *the hot sterile water* supply.

Seventh Step.—*Collect such unsterile articles as you are likely to need.* Blankets and hot water bottles are always easily secured; one or two kitchen pails of any sort will answer for floor basins; a pillow for the patient's head and several others for adjustment of the patient's position should be ready; one or two extra unsterile sheets, and a few towels will be needed; adhesive plaster, bandages, and safety pins are, of course, elementary provisions for all operations.

You should, of course, think of the possibility of *a hypodermic* of some stimulant or sedative and make a rule of having your own syringe in readiness, though the surgeon or anesthetist will doubtless see to this also.

Provision for the *preparation of the operative field* should also

be made and you should have at hand whatever of the probable things you can secure. Soap and alcohol will nearly always be available, and in the modern household you will be very likely to find iodine. This is another responsibility of which the surgeon will probably relieve you.

Eighth Step.—*If the rubber gloves have not been otherwise prepared you will now boil them* for about 15 minutes with the basins and other things which have been boiling and then store them in one of the basins in some antiseptic solution. It is always a good plan when boiling a number of gloves to put them into a bag for the process. This makes handling easier and safer, and the parcel itself can simply be placed in the solution basin and the gloves used directly from it without any previous handling.

You may or may not need to concern yourself about the *instruments* as the surgeon may bring them with him at the last moment ready for use. However, unless you know that this will be the case you should have boiling soda water ready for them in a suitable basin; or, if you have them in advance, now is the time to see that they are boiled. If you have the advantage of an electric or gas boiler or a portable stove of any kind which may be heated in the operating room, that will be ideal, as it is always a comfort to have the instrument boiler reasonably near the operating table.

Great care must always be taken, however, with *an open fire* of any kind in the operating room to keep it a safe distance from the ether, chloroform, or ethyl chloride, as these anesthetics are highly inflammable. Also, intense heat, and particularly an open flame, decomposes chloroform vapor and forms phosgene and hydrochloric acid gases which, if released in a poorly ventilated or small room, may seriously irritate the eyes and the respiratory tract of the occupants. If ethylene is to be the anesthetic, however, no fire of any kind can be used after the anethesia has been started because ethylene is a highly explosive gas. When this gas is liberated in an apartment or house the whole household must be warned of it so that there will be no source of ignition anywhere until the house has been thoroughly aired after the operation.

Ninth Step.—All unsterile supplies being in place, and the sterile ones either ready or almost so, about one-half hour before

the appointed time for the operation you should *begin the sterile preparation of the room.*

You have, of course, provided a place and the supplies for *sterilization of the hands.* The bathroom basin will probably answer this purpose whether you are using the room for the operation or not. Any running water available should be utilized, but in cases where there is none you will need to provide hand basins and plenty of both unsterile and sterile water in pails or pitchers. The method of hand sterilization you prepare for will depend upon what antiseptics you can get, but in most cases you can follow one of those suggested on page 319.

The general technic for "setting up" the room can be the same as in the hospital. Your sterile basins, instruments, etc., are in the kitchen or wherever you may have boiled them, and if they cannot be transported sterilely by an unsterile assistant you may have to bring them yourself after you are sterile. If you have used a wash boiler the probability is that everything is in it (with the exception of the instruments which you may have boiled separately) and unsterile assistants can carry this to the operating room when you are ready for it.

Dispose all the sterile supplies as accessibly as possible, for assistants will usually be fewer in the home than in the hospital and you will have to perform more than the usual duties assigned to one person there. Also, plan well ahead for the unsterile work, because you may have to depend upon untrained persons for this.

The first one or two operations with which you assist in the home, especially if you have finished your hospital training recently, will seem somewhat confused technically; but if you have kept everything sterile and have avoided wastage of time for your patient you have succeeded well and have doubtless broadened your education to the extent of learning that there is more than one good way to do everything. You must never expect to graduate in this branch of work, however, for no two homes will present the same problems, and you will always need to be prepared to rise to new occasions.

The general directions for *draping* given in Chapter XVII on pages 324 to 347 may be followed in the home operation, though greater economy in sheets and towels will often be obligatory. Some of the draping accompaniments, such as sandbags, rubber

sheets, towel clamps, etc., will doubtless be missing, but pillows, rolls of newspaper or magazines, etc., well bound together will take the place of sandbags; newspaper or oilcloth will nearly always answer for a rubber sheet; and safety pins will make good towel clamps if artery forceps cannot be spared.

As cautioned above, have all sterile supplies within as easy reach from the operating table as possible because your duties will probably be manifold during the operation, and you may need to hold a retractor, for instance, with one hand while you perform the instrument passer's duties or the general assistant nurse's duties with the other. As in all operating room management, time spent in preliminary planning and the exercise of good common sense will be your best investments.

Your duties after the operation will depend upon circumstances, but in any case you will make sure that all the household articles which were used for the operation are put into proper condition again for home use. This applies in a special way to the household linens. All blood-stained pieces should be rinsed clear of blood, and infected ones should be soaked in some antiseptic solution such as 1-40 carbolic or 1 per cent. formalin; for it should be remembered that servants and members of the family naturally shrink from these things, and that outside of hospitals laundries are probably not prepared to treat them properly. Likewise, you are the person to see that all soiled gauze is safely disposed of, and that the other articles which have been used are thoroughly cleansed and resterilized. Also, if the floor, walls, or other parts of the room have been contaminated in any way the responsibility is yours of seeing that they are restored for family use. In other words, you do as a well-trained nurse always does, namely, leave things as you found them. Where servants are plentiful you will doubtless be relieved of most of the reorganization of the room, but sterilization is a professional responsibility and you should not delegate any part of it to untrained persons.

What you do in the home with instruments or other things which you or the surgeon may have brought in will depend upon whether you remain to nurse the patient or are free. If you can cleanse and resterilize these things without disturbance to the patient it will be better practice to do this before carrying

them about, but your chief concern should always be to restore the normal conditions of the home as soon and as unobtrusively as possible under existing circumstances.

IMPROVISED OPERATIVE POSITIONS

The arrangement of special positions will be rather difficult in cases where the surgeon does not provide the portable operating table, and even then some of the more elaborate attachments will doubtless be missing. The portable tables usually provide

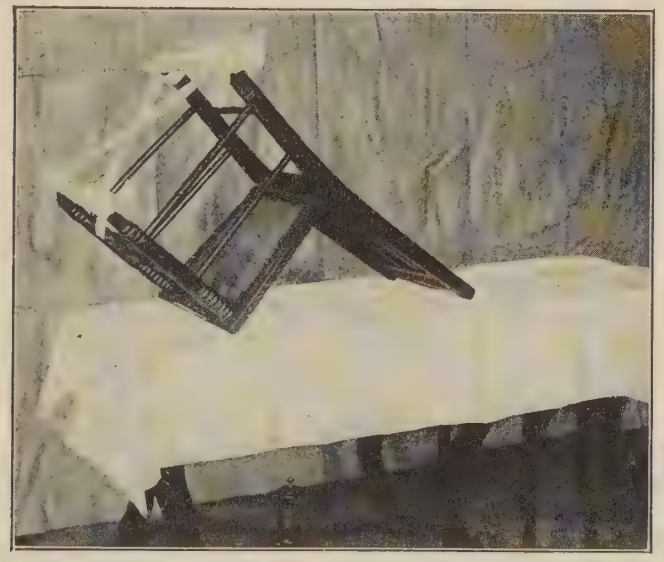


FIG. 170.—ORDINARY CHAIR ADAPTED FOR IMPROVISATION OF THE TRENDELENBURG POSITION. The bandage is first wound very tightly from leg to leg, and afterward, to keep it from slipping downward, it is lashed to each leg by tying a short piece of bandage tightly around it and over the end of the leg. It will be necessary to use plenty of pillows or folded blankets over the bandage and the back of the chair, both for the protection of the patient and for the adjustment of his position.

for the lithotomy and Trendelenburg positions, but for gall bladder and kidney positions you will need a substitute for the elevating attachment, and for arm cases you may need an arm board substitute. The following suggestions will provide ways out of these difficulties:

Trendelenburg Position.—Sometimes it may be possible to

incline the entire improvised table enough to answer the purpose, but a plan which can always be used in the home is to arrange a small chair on the table as illustrated in Fig. 170. To overcome the tendency of the patient to slide on this the shoulders may be lashed to the table by means of a strong bandage or a small sheet. Pillows and blankets must be freely used with this contrivance to pad or supplement it.

Gall Bladder Position.—All you will need for this is a suitable pillow to take the place of the usual table rest shown in Fig. 82, page 331.

Kidney Position.—A large pillow will be needed in this case to take the place of the table rest (Fig. 84, page 332). Other pillows will make good substitutes for the sandbags, but compact

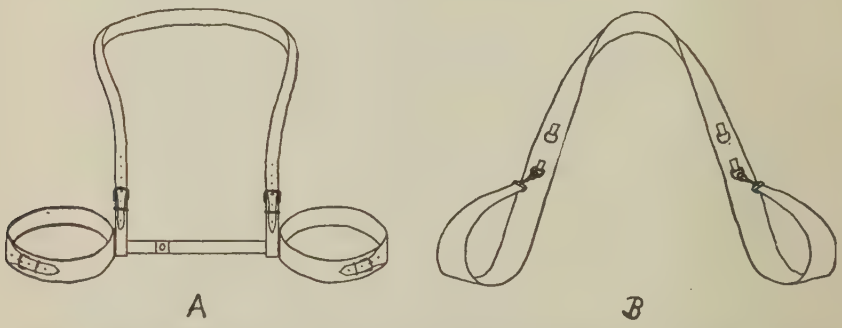


Fig. 171.—Lithotomy Crutches, or Leg Holders, for Supporting the Legs in the Lithotomy Position. A, of the illustration, shows the essential principles of the Clover crutch, which is adjustable in all parts. The leg straps are fastened around the thighs; the horizontal portion is made of metal and holds the legs from swaying sidewise; and the long strap passes underneath the back. *B* represents the Robb leg holder. This, also, is anchored under the patient's back.

bundles of old magazines or any other suitable articles, such as sheets, blankets, etc., may be fitted to the purpose.

Lithotomy Position.—Some means of supporting the legs will be your first concern for this position. There are several designs of "lithotomy crutches" (Fig. 171) on the market to which you may have access. Otherwise, a large sheet may be used as illustrated in Fig. 172. This sheet has been folded diagonally into a neat strap before application because it is more compact and stronger this way. Note that the sheet is passed on the outside of the thigh rather than the inside before it is tied or pinned below the knee, because otherwise the feet will tend to

turn inward where they will be in the way of the surgeon. If the knees tend to fall so far outward as to cause too much strain upon the hip joints the bandage shown in the illustration connecting the knees should be used, but this will not always be

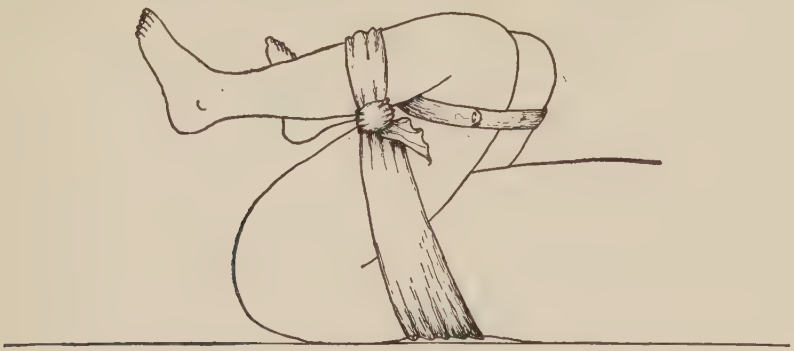


FIG. 172.—METHOD OF IMPROVISING A LITHOTOMY CRUTCH FROM AN ORDINARY SHEET FOLDED INTO A STRAP, WITH THE ADDITION OF A FEW TURNS OF A BANDAGE ABOUT THE THIGHS IF NECESSARY.

necessary. A strong bandage or any other strap-like contrivance may be used instead of the sheet. In some cases where the operation is to be short and there are assistants available two persons may hold the legs in position.

FIG. 173.—IMPROVISED KELLY PAD. A rubber sheet or a piece of oilcloth, and a few newspapers rolled together and bent into a semicircle, combined as indicated, are all that one needs for this contrivance.

Some substitute for the Kelly pad will be necessary. For this you will require a waterproof sheet of some sort about a yard square. In the absence of a rubber sheet a piece of oil-

cloth can usually be found. Make a solid roll of newspaper 2 or 3 inches in diameter and 3 or 4 feet in length; bend this into a semicircle, lay it across one end of the rubber sheet and then roll the rubber sheet around this and turn them inward together until they are securely combined and are the desired size and shape. You should then have a pad like the one illustrated in Fig. 173.

If you know that there will not be an irrigation during the operation or that there will not be drainage of any kind from the wound this pad will not be needed.

A pillow or old magazines will make the substitute for the *sandbag* which you may or may not need under the hips.

Arm Position.—When an extra rest is needed for an arm case a small side table may be used; or, a small board of any kind may be slipped under the patient's body (underneath the table pad) and allowed to project as desired (Fig. 96, page 341). As a rule the weight of the patient will be all the anchorage necessary for this board, especially if it is long enough to extend well across the table.

You will find it helpful in all these problems of improvisation to take as your guiding star the result you wish to secure rather than the passing detail of making or finding an exact copy of some convenience you have learned to use in the hospital, because in emergency work getting the operation done is of more importance than elegance of equipment. This is not meant as an indorsement of neglect to do the best you can in any respect, but merely to urge emphasis upon essentials. In this, as in all human activities, experience will be the best teacher.

APPENDIX

SOLUTIONS

Since one cannot learn the subject of solution making without a clear knowledge of the various systems of weights and measures involved, the first lesson should be a careful review of the following tables:

Apothecaries' Weight

Pound		Ounces		Drams		Scruples		Grains
lb.		℥		ʒ		℈		gr.
1	=	12	=	96	=	288	=	5760
		1	=	8	=	24	=	480
				1	=	3	=	60
						1	=	20

Avoirdupois Weight

Pound		Ounces		Drams		Grains
lb.		oz.		dr.		gr.
1	=	16	=	256	=	7000.0
		1	=	16	=	437.5
				1	=	27.34375

Metric Weight

10 milligrams = 1 centigram
10 centigrams = 1 decigram
10 decigrams = *1 gram*
10 grams = 1 decagram
10 decagrams = 1 hectogram
10 hectograms = 1 kilogram
10 kilograms = 1 myriagram
10 myriagrams = 1 quintal
10 quintals = 1 tonneau

Apothecaries' or Wine Measure

Gallon		Pints		Fluidounces		Fluidrams		Minims
C.		O.		f℥		f ʒ		♏
1	=	8	=	128	=	1024	=	61,440
		1	=	16	=	128	=	7,680
				1	=	8	=	480
						1	=	60

Metric Dry and Liquid Measure

10 milliliters = 1 centiliter
10 centiliters = 1 deciliter
10 deciliters = *1 liter*
10 liters = 1 decaliter
10 decaliters = 1 hectoliter
10 hectoliters = 1 kiloliter
10 kiloliters = 1 myrialiter

Equivalent Weights

Apothecaries'				*Avoirdupois*				*Metric*
			1.0 gr. =				**1.0** gr. =	0.0648 Gm.
			15.432 " =				15.432 " =	**1.0** "
			27.343 " =			**1.0** dr. =	27.343 " =	1.772 "
		1.0 ℥ =	60.0 " =			2.19 " =	60.0 " =	3.888 "
	0.91 ℥ =	7.29 " =	437.5 " =		**1.0** oz. =	16.0 " =	437.5 " =	28.35 "
	1.0 " =	8.0 " =	480.0 " =		1.097 " =	17.55 " =	480.0 " =	31.103 "
1.0 lb. =	12.0 " =	96.0 " =	5760.0 " =		13.17 " =	210.65 " =	5760.0 " =	373.251 "
1.22 " =	14.58 " =	116.66 " =	7000.0 " =	**1.0** lb. =	16.0 " =	256.0 " =	7000.0 " =	453.59 "
2.68 " =	32.15 " =	257.2 " =	15432.0 " =	2.2 " =	35.27 " =	564.4 " =	15432.0 " =	**1000.0** " (1 Kilo.)

Equivalent Measures

Apothecaries' (Wine)	*Metric*
1.0 ♏ =	0.062 c.c.
16.23 " =	**1.0** "
1.0 *f*℥ = 60.0 " =	3.72 "
1.0 *f*℥ = 8.0 " = 480.0 " =	29.76 "
3.38 " = 27.05 " = 1623.0 " =	100.0 "
1.0 O. = 16.0 " = 128.0 " = 7680.0 " =	473.2 "
2.11 " = 33.8 " = ...	1000.0 " = **1.0** liter
1 C. = 8.0 " = 128.0 " = ...	3785.5 " = 3.785 liters

It may be well to remind the student here that when the English systems of weights and measures are used in computing problems in solutions it is the *Apothecaries' Weight*, and not the Avoirdupois Weight, which applies. The grain is the unit for both and it is, of course, the same standard grain, but when we come to drams, ounces, and pounds we find a considerable difference in their values. The above table of equivalent weights will show this graphically.

Another point to be clarified in the beginning of the subject is the comparison or, in another sense, the distinction between the Apothecaries' Weight and the Apothecaries' Measure. These two systems have the terms dram and ounce in common, with the same number of units in them, namely, 60 and 480 respectively. This fact facilitates our calculations in some respects, but on the other hand it occasionally misleads a beginner into confounding the two systems. If the habit is formed of remembering the accurate terms, *fluid dram* and *fluid ounce*, for the Measure no confusion will occur in this respect.

A solution, in the limited sense of this discussion, is a liquid which has dissolved within it some solid, gas, or other liquid substance.

Liquids differ greatly as to the amount of any given substance they can hold in solution, each one varies with its temperature, and also there are wide differences among the various substances as to the amounts of them which any given liquid is capable of dissolving. The differences pertaining to the various liquids themselves are not of practical interest to the nurse because water is about the only solvent she uses, so the following remarks about solutions will refer to those made with water, and the substances considered will be only the more common ones which the nurse will encounter in everyday practice.

Two extreme instances of the limitations which substances impose upon the solvent power of water are those of silver nitrate and boric acid. We can dissolve in 1 ounce of water at a certain temperature more than 2 ounces of silver nitrate but only about 25 grains of boric acid, and if we put any greater proportions of one of these substances into the water the excess will merely remain undissolved either in the bottom of the container or in suspension in the water, and the solution itself will be what is called a saturated one. Likewise, there is a definite saturation point for every other substance.

A saturated solution of any given substance, then, is one in which the liquid is holding in solution all of the substance which it is capable of dissolving.

The power of water to dissolve any substance, however, varies with the temperature, the rule being that the higher the temperature the more it can hold in solution. Therefore, the term "saturated solution" is only a relative one. In the following table of a few substances frequently used by the nurse are given the amounts of water in which 1 gram of the substance makes a saturated solution. The figures are those given in the United States Pharmacopœia, and they apply only when the water is at the temperature of 25° Centigrade (77° Fahrenheit), which is the temperature adopted in the Pharmacopœia as the

standard normal one. The milliliter is used in the table as the unit of volume instead of the cubic centimeter, but although the two units are not quite identical they are given the same apothecary equivalent (16.23 minims) and it does not matter, for present purposes, which term is applied.

Table of Amounts of Water in Which 1 Gram Makes a Saturated Solution

Alum	7.2 mils
Bichloride of mercury	13.5 "
Boric acid	18.0 "
Carbolic acid	15.0 "
Magnesium sulphate	1.0 mil
Potassium permanganate	13.5 mils
Silver nitrate	0.4 mil
Sodium bicarbonate	10.0 mils
Sodium chloride	2.8 "

The practice, sometimes recommended to nurses, of *making a saturated solution,* such as boric acid, by merely putting into the water a little more of the substance than it will hold, is not a refined one because the excess is always in the container and if it is not in suspension it is in the bottom of the container and becomes mixed in solid form with the solution every time it is agitated. Furthermore, the strength of the solution will not be constant because, as pointed out above, this will vary with the temperature. The nurse's best course in making all solutions will be to *measure all ingredients accurately* and she will then know exactly what she is using.

With a table of figures at hand for reference a saturated solution is easy to make, but this strength of any substance is not often used and the nurse's chief concern will be about the weaker solutions which she will have to make either from the undissolved substance, the saturated solution, or from a solution of some other strength.

The strengths of solutions are indicated either by the per cent. method, as a 5 per cent. solution; or by the arithmetical ratio method, as a 1 in 20 solution (usually written 1-20); both terms showing the ratio which the weight of the solid substance bears to the corresponding measure of the finished solution. That is, they will stand for grains in minims, ounces in fluid ounces, etc. For large quantities, of course, multiples of these units are substituted in practice, and for smaller quantities fractions will enter into the computation.

The per cent. method of reckoning solutions is often very puzzling to beginners, but it is in reality comparatively easy because it involves only the simple rudiments of percentage. The term per cent. means merely, by the hundred, and the symbol, %, is only an abbreviated form of 1/100. The 5% solution, then, could be designated as a 5/100 (five one-hundredths) solution, or a 5 in 100 solution, which means that there is the proportion of 5 grains in every 100 minims. This is the same as a 1 in 20 solution, since, if there are 5 parts in every

100 parts there must be 1 part in every one-fifth of 100, or 1 in every 20. Similarly, the process of division may be carried into fractions, for if there is 1 in 20, there must be ½ in 10, and ¼ in 5. The minim, of course, is not divisible in practice, but the grain may be fractioned indefinitely, as will be shown later on. Also, instead of dividing both these numbers they may be multiplied, which will be convenient in case large quantities of solutions are to be made, and thus the 1-20 solution could be considered a 10 in 200 or a 50 in 1000 solution, and so on indefinitely, though the practical plan in this case is to use a larger unit such as the dram, the ounce, etc. Similarly, a 25% solution may be designated as a 25/100, 25 in 100, 1 in 4, or a ¼ in 1 solution, and so on for any per cent. of strength.

As stated above, a minim cannot be divided in our everyday practice and this sometimes presents a problem which cannot be thus analyzed down to the grain and minim units. In an 8% solution, for example, there would be 8 grains in 100 minims, 4 in 50, and 2 in 25, beyond which it is not practicable to go because the next division would be 1 grain in 12½ minims. A way to deal with such a case, however, is suggested later on.

Fractions of 1% are a little different problem, but they present no difficulties if they are regarded as merely fractions of 1/100. For instance, a ⅕% solution is a ⅕ of 1/100, a 1/500, or a 1-500 solution.

In actual practice frequently, when large quantities of a solution are to be made, it will not be practicable to measure the solutions in minims; and it will be rather awkward to reconcile the fluid dram, with its 60 minims, and the fluid ounce, with its 480 minims, with the per cent. (1-100) system of reckoning. An easy way out of this difficulty will be to figure in terms of multiples of these measures which contain even hundreds of minims as, for examples, 5 fluid drams (300 minims), 5 fluid ounces (2400 minims), and so on.

We can now make a solution such, for instance, as a 2% or a 2-100 one of boric acid, for all we need to do is to take 2 ounces of boric acid and add enough water to it to make 100 ounces in all. The student should learn, before she goes further, that it would be wrong to make this solution by adding 2 ounces of boric acid to 100 ounces of water because the finished solution would contain more than 100 ounces and we should then have 2 in more than 100. Neither would we have 102 ounces of solution in such a case because the ounces of the solid substances are determined by apothecaries' weight and those of water by apothecaries' measure, and they are not, therefore, to be reckoned as equal. If we start out to make 100 ounces and make all calculations for that amount we must see that we have exactly 100 ounces when we have finished.

All but a few solutions are more easily and quickly made with warm water than with cold, and as they are nearly always warmed for use it will be the best practice to *warm the water* first.

The temperatures of water understood by the terms "cold," "warm," etc., as adopted in the U. S. P., are as follows:

Cold water	15°-25°	Centigrade
Lukewarm water	35°-40°	"
Warm water	60°-70°	"
Hot water	85°-95°	"

In measuring minims of any solution the student must remember that the drop is not a permissible substitute for the minim. The minim is an invariable and standard unit of measure, while the size of the drop varies with many conditions, chiefly the size and shape of the dropper, the temperature of the liquid, and the nature of the liquid. Under standard conditions a drop of distilled water will equal a minim, and the same will be true of a few other liquids, but among the great majority of liquids there are striking differences in the size of the drop. To get a picture of the inequality of drops and minims the student will do well to study the following table which shows the number of drops in a fluid dram of a few familiar liquids under standard conditions. The fluid dram, of course, is a standard measure containing 60 minims.

Table of Drops in a Fluid Dram

Water	60
Dilute hydrochloric acid	60
Glycerine	67
Castor oil	77
Balsam of Peru	101
Tincture of digitalis	128
Tincture of nux vomica	140
Aromatic spirit of ammonia	142
Alcohol	146
Tincture of iodine	148
Ether	176
Chloroform	250

The *teaspoon* is rated in the Pharmacopœia as equivalent to a fluid dram, the *dessert spoon* to 2 fluid drams, and the *tablespoon* to 4 fluid drams. However, ordinary household spoons vary considerably from the standard, some which are called teaspoons, for instance, holding fully 2 drams. An accurately graduated measure is the one to use for making solutions.

The nurse will usually have a prescription to guide her as to the strength of any solution she is to use, but a reference list of the usual strengths of the more common ones follows.

Usual Strengths of Solutions

Alcohol	70% to 95%
Argyrol	1–1000 to 25%
Bichloride of mercury	1–10,000 to 1–1000
Boric acid	2% to 5%
Carbolic acid	1–60 to 1–20

Usual Strengths of Solutions (Continued)

Creolin	½% to 2%
Formalin	½% to 10%
Glucose	5% to 50%
Ichthyol	3% to 50%
Iodine	1–2000 to 7%
Lysol	½% to 2%
Picric acid	5%
Potassium permanganate	1–10,000 to sat. sol.
Silver nitrate	0.1% to 5%
Sodium bicarbonate	1% to 10%
Sodium chloride	0.6% to 0.9%

The real problems of solution making, however, arise when we have quantity and strength prescribed for us, and have probably only one strength of stock solution from which to draw. These are the problems which we shall have presented to us repeatedly in our daily practice, and we shall often need to work quickly, so it is obligatory upon every nurse to master the subject of solutions and to have at her immediate command one or more of the various methods of computation. Practice is the only means of attaining this. We give below a few representative problems, and if the actual making of the solution in the laboratory can accompany the solving of the problem, so much the better.

In these problems the per cent. and ratio designations of solution strengths will be intermingled, and the student should make it a point to be able to translate from one to the other at sight.

Tablets and powders, as our source of supply, will not entail any difficulties except those which arise also with the various stock solutions, so we shall use stock solutions chiefly and the tablet and powder problems will take care of themselves at the same time.

Problem 1.—*Make 5 ounces of 2% silver nitrate solution from a 25% stock solution.*

In quantities no larger than this it will be best to reduce the ounces to minims, first of all.

Then, $5 \times 480 = 2400$

The total number of minims desired, therefore, is 2400; and as 2%, or $\frac{2}{100}$ of this amount is eventually to be silver nitrate,

then, 2% of 2400

or, $\frac{2}{100} \times 2400 = 48$, the number of grains needed.

The next step is to get this 48 grains from the 25% stock solution; and this solution may be analyzed thus:

25 grains = 100 minims
5 " = 20 "
1 grain = 4 "

To get the 48 grains, then, we take from the stock bottle 48 times the quantity which contains 1 grain, or,

$48 \times 4 = 192$, the number of minims to take,
= 3 drams, 12 minims.

In *mixing the solution* remember that this 3 drams and 12 minims are to be a part of the total 5 ounces prescribed instead of being an addition to it. The practical way of measuring, if a large enough measure is at hand, will be to put the 3 drams and 12 minims into it first and then add water up to the 5-ounce mark. If a smaller measure must be used, the only way will be to reckon the difference between the 5 ounces and the 3 drams and 12 minims and measure out only that amount of water.

Students who are familiar with the subject of *algebraic proportions* may find that method more satisfactory to use, and it can be applied to any problem in solutions. In the above problem we can proceed with it thus: The quantity of 25% solution which we must use will bear the same relation to our final quantity of 2% solution that 2% bears to 25%.

This will be very clear and easy to remember if we write the proportion thus:

$$\text{Lesser quantity} : \text{Greater quantity} = \text{Lesser strength} : \text{Greater strength}$$

To state this proportion in algebraic symbols let

x = quantity of stock solution we must use
a = quantity of dilute solution we are making
b = strength of dilute solution we are making
c = strength of stock solution

and we then have

$$x : a = b : c$$

Substituting the values as used in the above solution of the problem, and solving for x, we have

$$\begin{aligned} x : 2400 &= 2\% : 25\% \\ 25x &= 2 \times 2400 \\ &= 4800 \\ x &= 192 \end{aligned}$$

To familiarize ourselves with the *various forms in which problems may be stated*, and the several ways in which they may be solved, let us use this same solution and study it from a few more angles.

Problem 2.—*How much of a 1–4 solution of silver nitrate will be needed to make 5 ounces of a 2% solution?*

$$\begin{aligned} 2\% \text{ of } 2400 &= \tfrac{1}{50} \text{ of } 2400 \\ &= 48 \end{aligned}$$

The 1–4 solution has 1 grain in every 4 minims and

$$4 \times 48 = 192$$

Or, let x = the number of minims of the 1–4 solution needed,
and 1–4 = 25%
Then, we have exactly the same problem as in problem No. 1

$$\begin{aligned} x : 2400 &= 2\% : 25\% \\ 25x &= 4800 \\ x &= 192 \end{aligned}$$

Or, let x = the number of minims of the 1–4 solution needed,
and 2% = 1–50

Then,
$$x : 2400 = 1\text{–}50 : 1\text{–}4$$
$$= \tfrac{1}{50} : \tfrac{1}{4}$$
$$= 4 : 50$$
$$50x = 9600$$
$$x = 192$$

Problem 3.—*How many grains of silver nitrate will be needed to make 5 ounces of a 2% solution?*

2% of 2400 is silver nitrate
2% of 2400 = .02 x 2400, or,
$= \tfrac{1}{50}$ x 2400
= 48

Let x = the number of grains needed,
and 2% = 1–50
Then,
$$x : 2400 = 1 : 50$$
$$50x = 2400$$
$$x = 48$$

This statement of ratios may seem, at first thought, not to be consistent with the "lesser" and "greater" formula given under Problem No. 1 because the 1 : 50 ratio does not literally represent two solutions. It is, however, the equivalent of the corresponding ratios in the preceding problems for, if we imagine each grain of the dry silver nitrate as dissolved in a minim of water, the solution would be a 100%, a 100–100, or a 1–1 solution. It happens to be possible actually to make such a solution with silver nitrate (see page 476), but whether possible or not we can assume it for mathematical purposes. Then, since the 2% solution is a 1–50 solution we can state our proportion thus :

$$x : 2400 = 1\text{–}50 : 1\text{–}1$$
$$= \tfrac{1}{50} : \tfrac{1}{1}$$
$$= 1 : 50$$

Problem 4.—*What is the strength of a silver nitrate solution in which there are 48 grains of silver nitrate to every 5 ounces?*

48–2400 reduced merely to lowest terms = 1–50
Or, let x = the per cent of strength.
Then, x–100 = the ratio of strength.
Hence,
$$x : 100 = 48 : 2400$$
$$2400x = 4800$$
$$x = 2$$
and
$$x\text{–}100 = 2\text{–}100$$
$$= 1\text{–}50$$

Problem 5.—*In 5 ounces of 1–50 silver nitrate solution how much of a 25% solution would there be?*

5 ounces = 2400 minims
For every 50 of these 2400 minims there is 1 grain of silver nitrate.
$\tfrac{1}{50}$ of 2400 = 48

The 25% solution has 1 grain in every 4 minims.

$$4 \times 48 = 192$$

Or, let x = the number of minims of the 25% solution needed,
and 1–50 = 2%

Then,
$$x : 2400 = 2\% : 25\%$$
$$25x = 4800$$
$$x = 192$$

Problem 6.—*How much 2% solution can be made from 48 grains of silver nitrate?*

A 2% solution = 1–50
1 grain in 50 minims = 48 grains in 2400 minims

Or, let x = the number of minims that can be made,
and 2% = 1–50

Then,
$$48 : x = 1 : 50$$
$$x : 48 = 50 : 1$$
$$x = 2400$$

Problem 7.—*Make 2 quarts of 1–1000 bichloride solution from a 1–8 solution.*

2 quarts = 64 ounces
= 30720 minims
$\frac{1}{1000}$ of 30720 = $\frac{768}{25}$ = $30\frac{18}{25}$

Then, $30\frac{18}{25} - 30720 = 1–1000$

There is 1 grain in 8 minims of the stock solution. Then, there are $30\frac{18}{25}$ grains in

$$30\frac{18}{25} \times 8 = 245\frac{1}{25} \text{ minims}$$

By proportion,
let x = the number of minims of the 1–8 solution needed.

Then,
$$x : 30720 = 8 : 1000$$
$$1000x = 8 \times 30720$$
$$x = 245\frac{1}{25}$$
= 246 minims, approximately.

Problem 8.—*Mix a pint of iodine solution, using 1 dram of the tincture. What is the strength of the solution?*

$$60–7680 = 1–128$$

Thus, we easily see that we have a 1–128 solution of the tincture of iodine.

Tincture of iodine, however, is a 7% solution of iodine.

$$7\% = 7–100$$

If there are 7 grains of iodine in 100 minims of the tincture how many grains are there in a dram?

$$7–100 = \frac{1}{100} – 1$$
$$= \frac{420}{100} – 60$$
$$= 4\frac{1}{5} – 60$$

By proportion,
let x = the number of grains in a dram.
Then, $60 : 100 = x : 7$
$x : 60 = 7 : 100$
$100x = 420$
$x = 4\frac{1}{5}$

In the dram, then, there are $4\frac{1}{5}$ grains of iodine, and the ratio of the pint solution is,

$4\frac{1}{5} - 7680 = 1\text{–}1828$ approximately.

Problem 9.—*Make a quart of 1–60 carbolic acid solution, using a 95% stock solution.*

It is often assumed that this problem means 1 of the 95% solution in 60 rather than 1 grain of pure carbolic acid in 60. Or, what amounts to the same thing, the 95% carbolic in that case is treated as though it were pure carbolic. Figuring on the basis of this assumption the problem is easy for,

1 quart = 32 ounces
$\frac{1}{60}$ of 32 = $\frac{32}{60}$ = $\frac{8}{15}$ of an ounce
$\frac{8}{15}$ ounce = 256 minims, the amount of the 95% solution needed.

Or, by proportion,
let x = the number of minims needed.
Then, $x : 15360 = 1 : 60$
$60x = 15360$
$x = 256$

However, for practice in accurate figuring let us study the problem this way:

95% = 95–100
= 19–20
= $\frac{19}{20}$–1

There are, then, 19 grains of pure carbolic acid in every 20 minims of the stock solution, or $\frac{19}{20}$ of a grain in every minim.

1 quart = 15360 minims

In every 60 of these 15360 minims there is to be 1 grain of carbolic acid.
$\frac{1}{60}$ of 15360 = 256, the number of grains required.

To know how many minims of the 95% solution this 256 grains represents we must find how many $\frac{19}{20}$ of a grain there are in it.

$256 \div \frac{19}{20} = 256 \times \frac{20}{19}$
= $269\frac{4}{19}$, the number of minims required.

By proportion,
let x = the number of grains needed.
Then, $x : 15360 = 1 : 60$
$60x = 15360$
$x = 256$

To get the 256 grains from the 95% solution,
let x = the number of minims needed.

Then, $256 : x = 95 : 100$

$95x = 25600$

$x = 269\frac{4}{19}$

Or, $x : 15360 = 1\text{–}60 : 95\text{–}100$

$= \frac{1}{60} : \frac{19}{20}$

$= \frac{1}{60} : \frac{57}{60}$

$= 1 : 57$

$57x = 15360$

$x = 269\frac{4}{19}$

Thus, 256 grains = $269\frac{4}{19}$ minims.

In so weak a solution as this the difference between these two numbers may be regarded as too small for consideration in ordinary practice, but the student should study the point involved and should learn the mathematics of the case regardless of practices in approximation.

Problem 10.—*Make a gallon of 1% formaldehyde solution from formalin.*

1 gallon = 128 ounces

1% of 128 = $\frac{1}{100}$ of 128 = $1\frac{2}{5}$

$1\frac{2}{5}$ ounces = 1 ounce, 2 drams, $14\frac{2}{5}$ minims

Formalin is a solution of "not less than 37% by weight" of formaldehyde. It is generally reckoned as a 40% solution.

Then, how much formalin will equal the formaldehyde we need?

40% = 40–100

= 2–5

= 1–$2\frac{1}{2}$

Therefore, we have 1 part of formaldehyde in every $2\frac{1}{2}$ parts of formalin; or, $\frac{2}{5}$ of formalin is formaldehyde.

1 ounce, 2 drams, $14\frac{2}{5}$ minims = $614\frac{2}{5}$ minims.

Then, $614\frac{2}{5}$ minims is $\frac{2}{5}$ of the amount of formalin we must use.

If $\frac{2}{5} = 614\frac{2}{5}$

$\frac{1}{5} = \frac{1}{2}$ of $614\frac{2}{5} = 307\frac{1}{5}$

and $\frac{5}{5} = 5 \times 307\frac{1}{5} = 1536$

1536 minims = 3 ounces, 1 dram, 36 minims

By algebraic proportion,

let x = the number of ounces of formaldehyde necessary.

Then, $x : 128 = 1 : 100$

$100x = 128$

$x = 1\frac{2}{5}$

Let x = the number of ounces of formalin necessary.

Then, $1\frac{2}{5} : x = 40 : 100$

$= 2 : 5$

$2x = 6\frac{2}{5}$

$x = 3\frac{1}{5}$

Or, $x : 128 = \frac{1}{100} : \frac{40}{100}$

$= 1 : 40$

$40x = 128$

$x = 3\frac{1}{5}$

$3\frac{1}{5}$ ounces = 3 ounces, 1 dram, 36 minims

What is the ratio of formalin in the 1% solution of formaldehyde?

Formalin = 40–100
= 2–5
= 1–2½
The solution = 1–100

Thus, 1 of formaldehyde in 100 = 2½ of formalin in 100.

2½–100 = ⅝–100
= 5–200
= 1–40

Or, 3⅛ : 128 = 1/100 : 4/100
= 1–40

Therefore, a 1% solution of formaldehyde, made from formalin, is a 1–40 formalin solution.

The above methods with their "approximate" and "near enough" results, in so many instances, are permissible for very weak solutions for external use, especially when making a large quantity, but suppose we are dealing with a dose of morphine. In such a case we must know some way to handle a fraction of a grain other than disregarding it either on the outside or the inside of our solution.

Problem 11.—*Give a dose of ⅙ of a grain of morphine from a solution labeled "Minims 5 = ¼ grain."*

¼–5 = 1–20
= ½–10
= ⅙–1⅔
= ⅙–3⅓

We cannot take exactly 3⅓ minims from our bottle, but we can get our exact ⅙ of a grain.

An easy, though extravagant, way to do it would be to take out 20 minims containing a whole grain, mix it with 4 minims of water, and then use a sixth of this new solution—4 minims.

If we know our arithmetic, however, we do not need to waste so much of the drug. We can take out only ¼ of a grain (5 minims) and add to this enough water to give us the ⅙ of a grain in some integral number of minims. First, however, we must find what fraction of the quarter grain the sixth of a grain is; or, since it is the same thing, we can find what fraction of 5 minims the 3⅓ minims is. Lest we have forgotten the arithmetic necessary for this, let us ask,

What fraction of 2 is 1?

$1 \div 2 = ½$

Similarly, What fraction of ¼ is ⅙?

$⅙ \div ¼ = ⅙ \times 4 = ⅔$

Or, What fraction of 5 is 3⅓?

$3⅓ \div 5 = 10/3 \times ⅕ = ⅔$

Or, by proportion,

let x = the number of minims containing ⅙ of a grain.

Then,
$$x : 5 = 1/6 : 1/4$$
$$x/4 = 5/6$$
$$6x = 20$$
$$x = 3\tfrac{1}{3}$$

Next, let x = the fraction which $3\frac{1}{3}$ is of 5.
Then,
$$x : 1 = 3\tfrac{1}{3} : 5$$
$$5x = 3\tfrac{1}{3} = {}^{10}/_{3}$$
$$x = 2/3$$
Also,
$$x : 1 = 1/6 : 1/4$$
$$x/4 = 1/6$$
$$6x = 4$$
$$x = 2/3$$

Now, we must get two-thirds of these 5 minims. Add enough minims of water to the 5 to make a number of minims which can be divided into thirds.

$$5 + 1 = 6$$
$$2/3 \text{ of } 6 = 4$$

$$5 + 4 = 9$$
$$2/3 \text{ of } 9 = 6$$

Thus we could go on indefinitely. If we are to give the drug hypodermically we must not, of course, use too much water, but when using this method where greater dilution will not matter it will be better to use a greater number of additional minims because any chance inaccuracy of measurement will not then make so much difference.

Problem 12.—*Make 1 ounce of 1–1000 bichloride solution from a 1–16 stock solution.*

If we wish to make this problem easy we can make 500 minims instead of an ounce of 480 minims. Then, since

$$1\text{–}1000 = 1/2\text{–}500$$

we can merely use 8 minims of our 1–16 stock solution. Other like problems, however, will not be as easy as this, and we shall profit more by reasoning out this problem in some such way as the following:

How much bichloride do we need?

$$1 \text{ ounce} = 480 \text{ minims}$$

If we need 1 grain in 1000 minims what part of a grain shall we need for only 480 minims?

$${}^{480}/_{1000} = {}^{12}/_{25}$$, the fraction which 480 is of 1000 and, therefore, the fraction of a grain needed.

Then we have,
$$1\text{–}1000 = {}^{12}/_{25}\text{–}480$$

How can we get $\frac{12}{25}$ of a grain from a 1–16 solution? Let us express 1–16 in terms of twenty-fifths.

$$1\text{–}16 = 1/25\text{–}{}^{16}/_{25}$$
$$= {}^{12}/_{25}\text{–}{}^{192}/_{25}$$

Therefore, we can call our 1–16 solution a $^{12}/_{25}$–$^{192}/_{25}$ solution, and it contains the desired $^{12}/_{25}$ of a grain in $^{192}/_{25}$ minims.

$$^{192}/_{25} \text{ minims} = 7\,^{17}/_{25} \text{ minims}$$

Take 8 minims from the stock solution.

$$8 \text{ minims} = \tfrac{1}{2} \text{ grain.}$$

Since the fraction of a grain we need is expressed in twenty-fifths ($^{12}/_{25}$) let us add enough minims to 8 to make the total number divisible into twenty-fifths. Clearly, 25 minims would be divisible into twenty-fifths, so we add 17 minims of water to the 8 and have

$$\tfrac{1}{2} \text{ grain in 25 minims} = \tfrac{1}{50} \text{ grain in 1 minim}$$
$$= \tfrac{1}{25} \text{ grain in 2 minims}$$

We wish $^{12}/_{25}$ of a grain so, 24 of the total 25 minims will contain this fraction; and this 24 added to 456 minims of water will give us the ounce of 1–1000 solution.

EQUIVALENT TEMPERATURE SCALES

	Centigrade Degrees	*Fahrenheit Degrees*	*Réaumur Degrees*
Boiling point of water	100	212	80
	95	203	76
	90	194	72
	85	185	68
	80	176	64
	75	167	60
	70	158	56
	65	149	52
	60	140	48
	55	131	44
	50	122	40
	45	113	36
	40	104	32
Normal body temperature	37	98.6	29.6
	35	95	28
	30	86	24
	25	77	20
	20	68	16
	15	59	12
	10	50	8
	5	41	4
Freezing point of water	0	32	0
	—5	23	—4
	—10	14	—8
	—15	5	—12
	—17.8	0	—14.24

The *Centigrade thermometer* is used in Europe and Latin-America chiefly, but it is considerably used also in the United States and most of the other countries. The *Fahrenheit thermometer* is used chiefly in the English-speaking countries. The *Réaumur thermometer* is used in Germany and somewhat in France and Russia.

The conversion of any given reading of one scale into its equivalent in the other is very easy. If 32 (the number of degrees below the freezing point in the Fahrenheit scale) is subtracted from 212 (the boiling point on the Fahrenheit scale) the remainder will be 180, which is the actual number of degrees on the Fahrenheit scale between freezing and boiling. On the Centigrade scale the corresponding number is 100, and on the Réaumur scale it is 80.

The relative values of the degrees on these scales, therefore, may be written

100 C. = 180 F. = 80 R.
5 C. = 9 F. = 4 R.

Remembering always to *subtract 32* from the Fahrenheit degrees before making comparisons and to *add 32* to them afterward, we can convert each scale into the others by the following formulae:

C. = $^{10}/_{180}$ = $^{5}/_{9}$ F.
C. = $^{10}/_{80}$ = $^{5}/_{4}$ R.
F. = $^{18}/_{100}$ = $^{9}/_{5}$ C.
F. = $^{13}/_{80}$ = $^{9}/_{4}$ R.
R. = $^{8}/_{100}$ = $^{4}/_{5}$ C.
R. = $^{8}/_{180}$ = $^{4}/_{9}$ F.

Example.—Convert 37° Centigrade into Fahrenheit and Réaumur.

$^{9}/_{5}$ of 37 = 66.6
66.6 + 32 = 98.6 Fahrenheit

$^{4}/_{5}$ of 37 = 29.6 Réaumur

Example.—Convert 122° Fahrenheit into Centigrade and Réaumur.

122 − 32 = 90
$^{5}/_{9}$ of 90 = 50 Centigrade

122 − 32 = 90
$^{4}/_{9}$ of 90 = 40 Réaumur

Example.—Convert 76° Réaumur into Centigrade and Fahrenheit.

$^{5}/_{4}$ of 76 = 95 Centigrade

$^{9}/_{4}$ of 76 = 171
171 + 32 = 203 Fahrenheit

ABBREVIATIONS AND SYMBOLS

ãā, *ana*, equal parts of each.
A.c., *ante cibum*, before meals.
Ad, to, up to.
A.D., *auris dexter*, right ear.
Ad 2 vic., *ad duas vices*, for two doses.
Add., *adde*, add to it.
Ad lib., *ad libitum*, whenever desired.
Ag, *argentum*, silver.
Al, aluminum.
Al. dieb., *alterius diebus*, every other day.
Alt. hor., *alterius horis*, every other hour.
Alt. noc., *alterna nocte*, every other night.
Aq., *aqua*, water.
Aq. astr., *aqua astricta*, ice.
Aq. bull., *aqua bulliens*, boiling water.
Aq. com., *aqua communis*, common water.
Aq. dest., *aqua destillata*, distilled water.
Aq. ferv., *aqua fervens*, hot water.
Aq. pur., *aqua pura*, pure water.
As, arsenic.
A. S., *auris sinister*, left ear.
At. wt., atomic weight.
Au, *aurum*, gold.
Av., avoirdupois.
Bi, bismuth.
Bib., *bibe*, drink.
B. i. d., *bis in die*, twice a day.
Bis, twice.
Bis hor., *bis horis*, every two hours.
Br, bromine.
Bull., *bulliat*, let it boil.
c̄., *cum*, with.
C, carbon, centigrade.
C., or Cong., *congius*, a gallon.
Ca, calcium.
Calef., *calefactus*, warm, let it be made warm.
Cap., *capiat*, let him take.
C.c., cubic centimeter.
Ce, cerium.
Cent., centigrade.
Cg., centigram.
Cib., *cibus*, food.
Cl, chlorine.
Cm., centimeter.
C. m., *cras mane*, tomorrow morning.
C. m. s., *cras mane sumendus*, to be taken tomorrow morning.

C. n., *cras nocte*, tomorrow night.
Cochl., *cochleare*, spoonful.
Cochleat., *cochleatim*, by spoonfuls.
Cochl. ampl., *cochleare amplum*, a tablespoonful.
Cochl. infant., *cochleare infantis*, a teaspoonful.
Cochl. mag., *cochleare magnum*, a tablespoonful.
Cochl. med., *cochleare medum*, a dessertspoonful.
Cochl. parav., *cochleare parvum*, a teaspoonful.
Col., *cola*, strain.
Colet., *coletur*, let it be strained.
Collut., *collutorium*, a mouth wash.
Collyr., *collyrium*, a mouth wash.
Comp., *compositus*, compound.
Cong., *congius*, gallon.
Cons., *conserva*, keep.
Contim., *contimetur*, let it be continued.
Cont. rem., *contimetur remedia*, let the medicine be continued.
Coq., *coque*, boil.
Coq. in s. a., *coque in sufficiente aqua*, boil in sufficient water.
C. P., chemically pure.
Crast., *crastinus*, for tomorrow.
Cu, *cuprum*, copper.
C. v., *cras vespere*, tomorrow evening.
Cwt., a hundredweight.
Cyath., *cyathus*, a glassful.
Cyath, vin., *cyathus vinarius*, a wine glass.
Decoct. hord., *decoctum hordei*, barley water.
Decub., *decubitus*, lying down.
De d. in d., *de die in diem*, from day to day.
Deg., degree.
Deglut., *deglutiatur*, let it be swallowed.
Dep., *depuratus*, purified.
Destil., *destilla*, distil.
Det., *detur*, let it be given.
Det. in dup., det. in 2plo, *detur in duplo*, let twice as much be given.
Dieb. alt., *diebus alterius*, on alternate days.
Dieb. tert., *diebus tertius*, every third day.
Dil., *dilue*, let it be dissolved.
Dil., *dilutus*, dilute.
Dim., *dimidius*, one-half.
D. in p., *divide in partes aequales*, divide into equal parts.
Div., divide.
Donec. alv. sol. fuerit., *donec alvus soluta fuerit*, until the bowels are opened.
Dr., dram.
Dur. dolor., *durante dolore*, while the pain lasts.
Ejusd., *ejusdem*, of the same.
Elix., elixir.

Emp., *emplastrum*, a plaster.
Emp. vesic., *emplastrum vesicatorum*, a blister.
Enem., enema.
Exhib., *exhibeatur*, let it be given.
Ext., extract, external.
F., *fac*, make.
Fahr., Fahrenheit.
Fe, *ferrum*, iron.
Feb. dur., *febre duranti*, while the fever lasts.
Fld., fluid.
F. mist., *fiat mistura*, make a mixture.
Fot., *fotus*, a fomentation.
F. pil., *fiat pilula*, make a pill.
Fract. dos., *fracta dosi*, in divided doses.
Freq., *frequenter*, frequently.
Ft., *fiat*, let it be made.
F$\bar{3}$, fluid dram.
F$\bar{3}$, fluid ounce.
Garg., *gargarisma*, a gargle.
Gm., gram.
Gr., grain.
Gtt., *guttae*, drops.
Guttat., *guttatim*, by drops.
H, hydrogen.
Hd., *hora decubitus*, at bedtime.
Hg, *hydrargyrum*, mercury.
Hor. decub., *hora decubitus*, at bedtime.
H. s., *hora somni*, at bedtime.
I, iodine.
Id., *idem*, the same.
In aq., *in aqua*, in water.
In d., *in die*, daily.
Inf., *infusum*, an infusion.
Inject., *injectis*, an injection.
K, *kalium*, potassium.
Kg., kilogram.
L., liter.
Lat. dol., *lateri dolenti*, to the painful side.
Lb., *libra*, a pound.
Li, lithium.
Lin., *linimentum*, liniment.
Liq., liquor.
Loc. dol., *loco dolenti*, to the painful spot.
Lot., *lotio*, a lotion.
M., *misce*, mix.
Mac., *macera*, macerate.
Man., manip., *manipulus*, a handful.
Man. pr., *mane primo*, early in the morning.

Mass. pil., *massa pilularum*, pill-mass.
Matut, *matutinus*, in the morning.
M. et N., *mane et nocte*, morning and night.
M. ft., let a mixture be made.
Mg, magnesium.
Mist., *mistura*, a mixture.
Mn, manganese.
Mor. dict., *more dicto*, in the manner directed.
Mor. sol., *more solito*, in the usual way.
N, nitrogen.
Na, sodium.
Ne rep., *ne repetatur*, not to be repeated.
Noct., *nocte*, at night.
Noct. maneq., *nocte maneque*, at night and in the morning.
Non repetat, *non repetatur*, do not repeat.
O, oxygen.
O., *octarius*, a pint.
O^2, both eyes.
O. d., *omne die*, every day.
O. D., *oculus dexter*, right eye.
Ol., *oleum*, oil.
Ol. oliv., *oleum olivae*, olive oil.
O. m., *omni mane*, every morning.
Omn. bih., *omni bihora*, every two hours.
Omn. hor., *omni hora*, every hour.
Omn. noct., *omni nocte*, every night.
O. n., *omni nocte*, every night.
O. S., *oculus sinister*, left eye.
O. U., *oculus uterque*, either eye.
Ov., *ovum*, an egg.
Oz., ounce.
P, phosphorus.
P. or pug., *pugillus*, a pinch.
Part. aeq., *partes aequales*, equal parts.
Part. vic., *partibus vicibus*, in divided doses.
Pb., *plumbum*, lead.
P. c., *post cibum*, after meals.
Pil., *pilula*, a pill.
Pond., *pondere*, by weight.
P. rat. aetat., *pro rata aetatis*, in proportion to the age.
P. r. n., *pro re nata*, according to need.
Pro, for.
Pt., pint.
Pulv., *pulvis*, powder.
Q. d., *quarter in die*, four times a day.
Q. h., *quaque hora*, every hour.
Q. i. d., *quarter in die*, four times a day.
Q. l., *quantum libet*, as much as you choose.

Q. p., *quantum placeat*, at will.
Q. q. h., *quaque quarta hora*, every fourth hour.
Q. s., *quantum sufficit*, as much as is necessary.
Qt., quart.
Quotid., *quotidie*, daily.
Q. v., *quantum vis*, as much as you wish.
Ra, radium.
Rad., *radix*, root.
Rect., *rectificatus*, rectified.
Rep., *repetatur*, let it be repeated.
S., *sine*, without.
S. or sig., *signa*, write.
Sat., saturated.
Sb, *stibium*, antimony.
Semih., *semihora*, half an hour.
Sig., *signetur*, let it be labeled.
Sig., *signa*, write.
Simul, together.
Sing., *singulorum*, of each.
Sol., solution.
Solv., *solve*, dissolve.
S. o. s., *si opus sit*, if necessary.
Sp., *spiritus*, spirit.
Sp. gr., specific gravity.
Spir., *spiritus*, spirit.
Spt., *spiritus*, spirit.
St., stet, let it stand.
Stat., *statim*, at once.
Ss., *semissis*, a half.
Su., *sumet*, let him take.
Sum., *sumendus*, to be taken.
S. v., *spiritus vini*, alcoholic spirit.
S. v. r., *spiritus vini rectificatus*, rectified spirit of wine.
S. v. t., *spiritus vini tenuis*, dilute alcohol, proof spirit.
Syr., syrup.
T., temperature.
T., *ter*, three times.
T. i. d., *ter in die*, three times a day.
Tinct., tincture.
Tr., tincture.
Ult. præs, *ultimum præscriptus*, last prescribed.
Ung., *unguentum*, ointment.
U. S. P., United States Pharmacopœia.
Ut dict., *ut dictum*, as directed.
Vitel., *vitellus*, yolk.
Vitel. ovi, *vitellus ovi*, yolk of egg.
Viz., *videlicet*, namely.
Wt., weight.

Zn, zinc.
ʒ, dram.
℥, ounce.
℈, scruple.
℞, recipe, take.
♏, minim.

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